SCIENTIFIC AMERICAN SUPPLEMENT. No 1392

Copyright, 1902, by Munn & Co

Scientific American, established 1845.
Scientific American Supplement. Vol. LIV, No. 1392.

NEW YORK, SEPTEMBER 6, 1902.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year

THE KRUPP BUILDING AT THE DUESSELDORF EXHIBITION.

THE KRUPP EXHIBIT AT THE DUESSELDORF EXPOSITION.

ONE of the most interesting pavilions at the Duesseldorf Exposition, now being held in Germany, is that of Friedrich Krupp, which is constructed somewhat in the form of a battleship and is known as Krupphall. An excellent illustration of the exterior of this building may be seen on our front page. On the

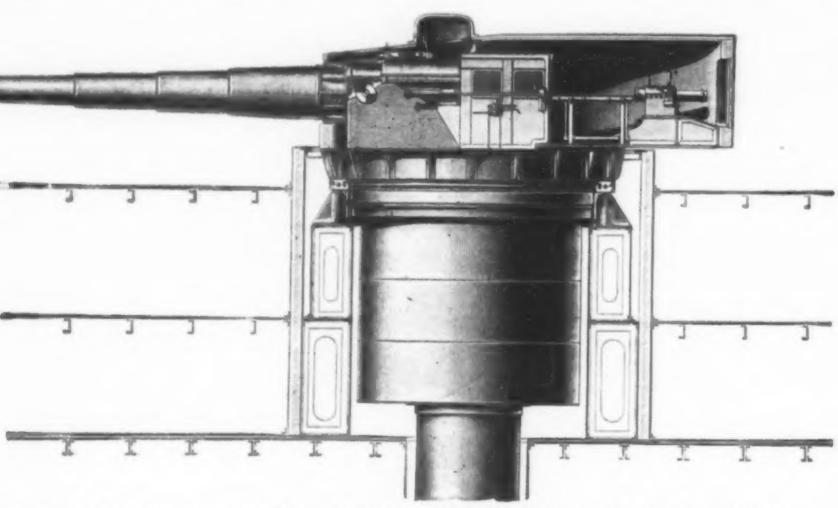


FIG. 1.—28 CM. GUN "L/40" MOUNTED IN CENTER-PIVOT NAVAL CARRIAGE.

top of the building there is constructed a battleship mast 54 meters high. The length of the building is 134 meters, while its width is 35 meters, the total floor space for exhibit being 4,280 square meters. The main ship construction is 110 meters long and 26 meters wide. Just outside of the building there is a fine exhibit of battleship armor, including an armor-plate weighing 106 tons, which is located near the entrance as viewed from the south. This armor-plate is 13.16 meters long, 3.4 meters wide and 30 centimeters thick and weighs 106,000 kilogrammes. There is exhibited in this hall along one entire side the shafting for the Kaiser Wilhelm II. of the North German Lloyd. This shaft is 45 meters long and weighs 52,700 kilogrammes. On one wall of the Krupphall is hung an enormous boiler-plate weighing 29,500 kilogrammes. This sheet of metal is 26.8 meters long, 3.65 meters wide and 38.5 millimeters thick. Among the interesting exhibits of parts of ship construction is included a large stern post and rudder frame, also a very fine line of torpedo boat engines and boilers of the latest construction. The pavilion known as Krupphall is located at the south end of the exposition grounds and is certainly one of the most important exhibits to be seen at the Rheinisch-Westfälische Industrie-Ausstellung.

It was not to be expected that the display of the large variety of artillery material represented at the Paris World's Fair of 1900 would be equaled by the Duesseldorf exposition of 1902. Nevertheless the latter presents to the expert a very extensive collection, which is especially interesting, as there appears here, for the first time, at one of the larger expositions a new representative of the gun-manufacture: the "Rheinische Metallwaaren und Maschinenfabrik Duesseldorf;" moreover, there are also represented, in great abundance, the newest types and constructions of ordnance produced in Krupp's factory.

NAVAL ORDNANCE.

If ship and coast defense guns are considered in the first place, there can be said about all the pieces of this type that their barrels are manufactured from a special kind of crucible steel and that they are all constructed upon the jacketed-tube system. For a breech closure Krupp uses for these guns, excepting the 15-centimeter coast-defense gun, his wedge-mechanism adapted for the use of metallic cartridge shells. The breech of the 15-centimeter gun is closed by a screw fitted with an asbestos ring.

The breech mechanism of these guns is constructed in such a manner that the firing can be done by electricity, as well as by hand. Krupp is of the opinion that the advantages resulting at times from the mechanism for firing heavy ship and coast defense ordnance by electricity are so considerable that all the exhibited pieces, from the 19-centimeter caliber gun upward, have been provided with his device. This step has been taken in consideration of the fact that the targets of ship and coast defense guns, as well as the guns themselves, are usually in motion. The latter statement does not refer to stationary coast defense guns, however; in this case the vessel is usually in motion against which said pieces have to keep up fire. Further, it will be advantageous in an engagement, if the gunner fires the moment that the object which he intends to strike comes into the sight-line. All these requirements are met most satisfactorily by the electro-magnetic discharging mechanism, or by the use of electric screw-primers. The first named device, with which firing by hand can be easily combined, is used in the Krupp guns. The firing device by electricity allows also the simultaneous firing of several guns to be effected from one point, a fact which in engagements on the high sea and near the coast may sometimes be of special advantage. The contact button for discharging the gun by electricity is placed in the stand provided for the gunner.

In the following description each gun will be considered separately.

The 28-centimeter gun "L/40" (Fig. 1).—Like all the other pieces, this gun is, in every respect, ready for use, being provided with all accessories, so that its traversing and elevating action, executed by machine power, is daily demonstrated. On the other hand, the local conditions have been such that the gun cannot be fitted up with the ammunition-hoist which, on vessels, runs down as far as under the armored deck, and which in reality is connected with the traverse platform so that it turns together with the latter; however, the gun shown in Fig. 1 is mounted in this manner. The traverse platform supports the frame in which the cradle reposes with its trunnions. When the gun is discharged it slides back in the cradle, and this backward motion is checked by two hydraulic record cylinders, arranged beneath it; the latter are connected with an interposed pneumatic cylinder which, during the recoil, receives the backward momentum and thus stores up the energy of the recoil to be used for running the gun out into the firing position. The traverse platform rests on ball-bearings which move in a circle and the balls of which run on the solidly secured base in a groove with semicircular section. To the interior part of the base a toothed rim is secured into which engages the main wheel of a gear. For traversing the gun the gear is operated by means of a hydraulic motor, likewise arranged under the traverse platform. The elevating gear, as well as the rammer and the ammunition hoist, are also worked by hydraulic power; however, they can, at the same time, be adapted for working by hand-gear. In order to give the required elevation to the barrel, the latter is elevated or depressed around the trunnions of the cradle by means of an hydraulic cylinder which stands vertically under the cradle in the traverse platform, while the motion of its piston is transferred to the cradle by means of guide-rods.

The hoisting shaft is secured to the traverse platform and therefore the ammunition hoist turns together with the latter, so that the gun can be loaded at any angle of traverse. The shaft ends above the traverse platform on the left side of the gun barrel, and through it are raised simultaneously the projectile, as well as the cartridge placed in trays, which are arranged one above the other, in such a manner that the upper tray contains the projectile. The rammer-head, which can be extended in a telescope-like manner, pushes the projectile over a laterally-swinging loading tray and brings it at first into the opening in the breech. When the gun-cartridge is rammed home an automatic reversing mechanism allows the rammer-head to project only so far as to push the cartridge forward until it touches the projectile, whereupon the rammer-head recedes instantaneously and automatically. The hydraulic rammer, as well as the loading-tray, which swings into the breech, cannot change their position, and allow therefore the loading to be performed only at a certain elevation of the barrel. The other parts engaged during the process of loading are free to move only after the barrel has been adjusted.

The position of the gunner is on the right side of the barrel, under the protecting shield. From this stand he can operate the lever of the elevating gear and of the traversing mechanism, as well as the contact-button for the electromagnetic firing apparatus.

The gun is protected from the fire of the enemy by an armor of untempered nickel-steel of 250 millimeters thickness; that part of the shield not exposed to the enemy's horizontal fire is 50 millimeters thick.

The 19-centimeter gun "L/40" (Fig. 2).—The cradle reposes with its trunnions in a pivot-fork which turns in the stationary pivot-support and is guided in the latter by the upper part of its shaft. This hollow shaft of the pivot-fork incloses a supporting-bolt which supports the entire movable system of the gun, the traversing action of the latter being facilitated by a small ball bearing. The pivot-support is provided on its upper part with a rack into which engages the worm of a worm-wheel gearing, with its hand-wheel arranged on the right side. The hand-wheel on the left side serves for actuating a worm-wheel gearing to give the required elevation. The recoil of the barrel is checked by a hydraulic cylinder, with the aid of two long springs, which cause the barrel to advance into the firing position. A clutch, secured to the front part of the pivot-support, supports the pivot-fork, when the recoil is communicated to the former, and counteracts thus the tendency of the barrel to be upset rearward. On the left side are arranged the telescopic sight and the rear and front sight of the device for night firing, with electric incandescent lamps which illuminate the rear sight and the front sight. This piece carries a steel shield of 100 millimeters thickness.

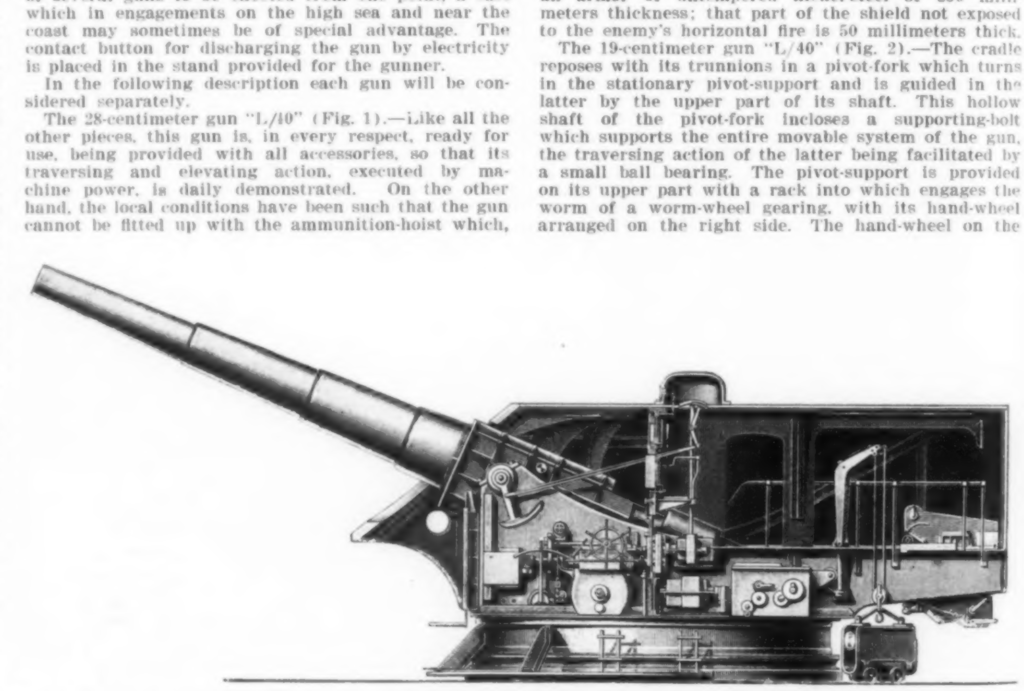


FIG. 3.—30.5-CM. GUN "L/40" MOUNTED IN CENTER-PIVOT COAST-DEFENSE CARRIAGE.

THE COAST-DEFENSE GUNS.

The 30.5-centimeter gun "L/40" (Fig. 3).—The recoil of the barrel in the cradle is checked by a hydraulic cylinder similar in construction to the one used in the 28-centimeter naval gun, except that in this case two pneumatic cylinders are provided. The carriage of the 30.5-centimeter coast-defense gun resembles that of the 28-centimeter naval gun. The cradle reposes with its trunnions in the frame, the latter is solidly connected with the traverse platform turning in a pivot-support. The traversing motion is facilitated by means of interposed ball bearings. The traversing and elevating gear, the ramming mechanism and the ammunition hoist are operated by electricity. The coupling manipulations required to throw into gear the mechanism for working by hand can be finished in a few seconds, whereby the circuit, for the operation by electricity, is automatically interrupted. The traversing gear is arranged in front on the traversing platform, between the sides of the chassis; a toothed wheel of the gearing engages into the rack secured to the pivot-support. The starting-lever for the traversing gear is placed in the gunner's stand on the right side of the barrel; by means of this lever the gun can be made to turn at any rate from the slowest speed, which is scarcely perceptible, to the fastest,

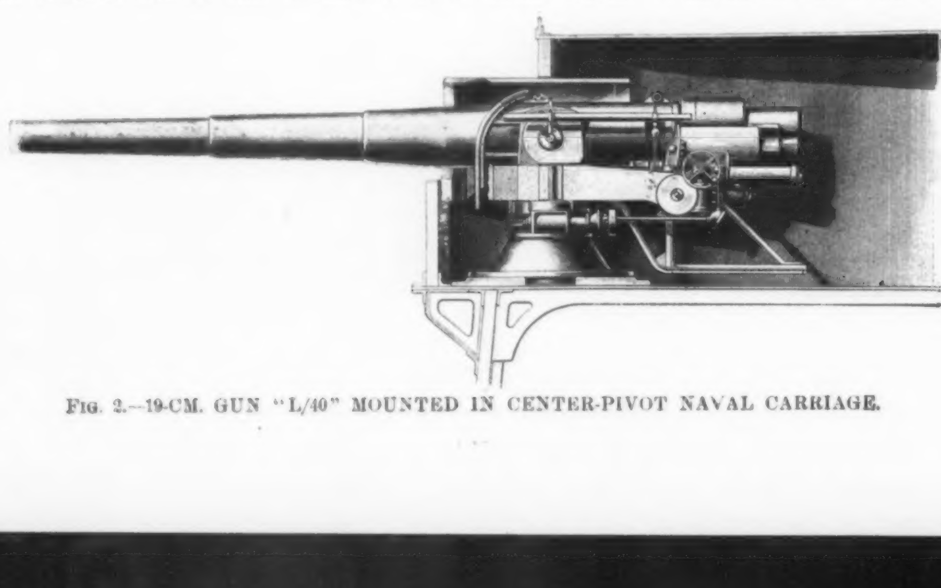


FIG. 2.—19-CM. GUN "L/40" MOUNTED IN CENTER-PIVOT NAVAL CARRIAGE.

Besides the front sight and rear sight, secured on the gun-barrel, there is also provided, in the stand of the gunner, a telescopic sight the mechanism of which enables the man to watch and to interrupt the movements of the barrel by means of the elevating gear.

The projectile and the gun-cartridge are brought to the gun, at the same time, on cars which are rolled over tracks. They are raised behind the barrel by two ammunition hoists, consisting of rotary crane with tackle arranged in the rear of the carriage and, finally, the projectile and cartridge are propelled into the barrel with the aid of a rammer worked by electricity. In order to allow the cars to be brought into the position required for loading the rammer remains lowered until the car is placed into loading position and, only after this has been done, it rises again. An automatic safety device allows the gun to be loaded it is lifted by a crane behind the breech-block of the barrel; the crane is operated by electricity. The crank for actuating the hand gear is on the left side.

A cone-shaped shield of pressed steel 60 millimeters thickness is supported by the traverse platform and protects the gun crew from shell fragments and solid shot thrown by guns of small caliber. The embrasure in said shield is closed during the recoil by an embrasure shutter secured to the top carriage.

The 21-centimeter gun "L/40" in disappearing-gun carriage (Fig. 5).—The illustration shows that the supports for raising and lowering the barrel rest with their horizontal axis in the frame so that they can turn, and that the frame reposes on a traverse platform which, in the manner of the center pivot ship carriages, is supported by circular ball bearings on the base or the pivot support and can be turned by push-lever arrangement. It is called so because the crank, which can be turned through an angle of 180 degrees in order to lock or unlock the breech catches with a peculiarly formed bar into the breech-block and by means of a certain pushing action turns the breech-block as far around as necessary to open or lock the breech. An asbestos pad is fitted on the breech-block behind the head of the vent. Hence charges in cartridge-bags have to be used in this gun instead of fixed ammunition. There is also provided a safety arrangement which prevents the premature opening of the breech and the accidental firing of the gun.

In the last moment of opening the breech a loading tray, attached beneath the bottom surface of the barrel, places itself automatically into the barrel and covers the threads of the breech, affording thus protection from injuries while the projectile is inserted.

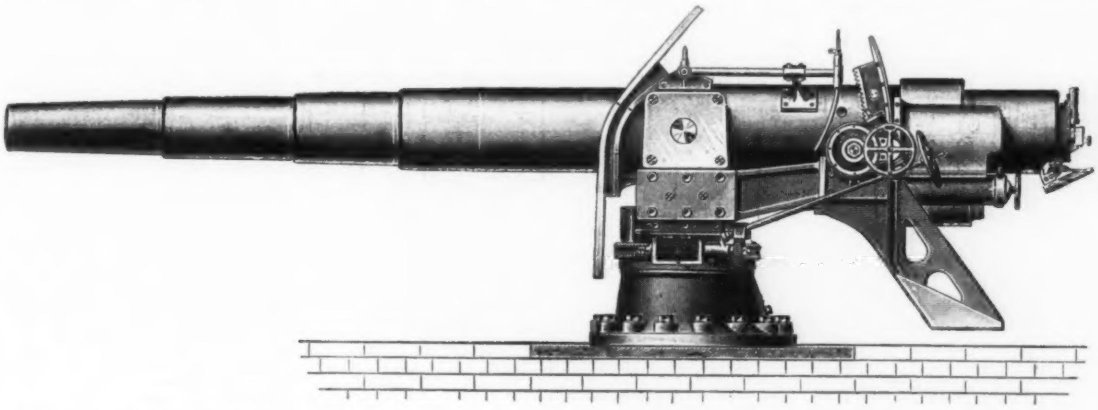


FIG. 6.—15-CM. GUN "L/40" MOUNTED IN CENTER-PIVOT CARRIAGE FOR COAST DEFENSE GUNS.

only after the latter, as well as the ammunition, has been brought into the position required for loading, and after the breech has been entirely opened. As soon as the limits of the traversing motion of the gun, as well as the limits of the barrel elevation and the limits of the movements of the ammunition hoist and of the rammer have been reached the circuit for operating the gun by electricity is automatically interrupted.

The shield has the form of a truncated cone; one-half of it in front consists of tempered nickel steel of 135 millimeters thickness. The vertical back side and the top are made of nickel steel in the state of natural hardness.

The projectile has a muzzle velocity of 15 250 meters and can pierce the heaviest armor plate with which vessels are clad at present, at any distance at which such vessels may be expected to engage in a fight with coast fortifications.

The 28-centimeter howitzer "L/12" (Fig. 4).—This gun has to be fired at high angles of elevation, while, at the same time, its traversing and elevating action must be such that it can follow quickly the passing vessels of the enemy. As these weapons are fired at high angles they can be mounted at a considerable depth behind the covering parapet, which protects them from direct horizontal fire of the enemy's guns of a greater caliber. Consequently these pieces need only an armor to protect them from shell fragments and solid shot of a smaller caliber. For this reason the construction of the howitzer cannon differs from that of horizontal fire guns.

The barrel, which is not supported by a cradle, reposes with the trunnions in a top carriage placed with its sides on the track inclined upward toward the rear of the frame; on the latter the gun slides back whereby it is checked with the aid of hydraulic cylinders which are arranged on the outer sides of the top carriage, while their piston rods are fastened to the front side of the frame. After the recoil the top carriage slides again automatically forward on the track inclined toward the front. The frame, with the traverse platform, turns as usual on circular ball bearings supported by the base. The gun is constructed so that it can be operated by electricity and by hand, it being free to traverse the entire circumference of a circle. The rack, into which the traversing gear engages, is secured to the outside of the base. On the right trunnion of the barrel a pointer is secured which runs in the direction of the bore and slides over a fixed graduated arc indicating the degree of elevation. The hand-wheel, shown on the right side, serves to give the piece the required elevation by hand gear.

The projectile is brought to the gun on a car, whence means of the hand lever of the traversing gear in order to traverse the gun to the desired position. Within the base is the counter weight, which, according to the dotted lines indicated in the illustration, is raised backward and thus stores up energy when the gun-barrel is lowered rearward. The lowering of the barrel is effected by the force of the recoil at each discharge of the piece. The raising of the counter weight causes a portion of the recoil energy to be absorbed. What remains is taken up by a recoil cylinder which retains the gun-barrel in position for loading, being assisted during this action by two safety latches. Only after the valve of the mechanism for running the gun into the firing position has been opened can the counter weight sink down, whereby the force of the recoil stored up therein is used for raising the gun to the firing position. The speed with which the barrel raises is regulated by a check in such a manner that it slides smoothly into the firing position. A tackle worked by hand gear and arranged on the front side of the frame serves for running in the barrel when it is not intended for firing. It takes only about four seconds to lift the barrel from the lower loading position into the raised firing position.

The elevation is given to the barrel by means of a hand-wheel, arranged on the left side. On turning this hand-wheel the rotary motion is transferred to two bars connected with the trunnions of the barrel. The projectiles are brought to the gun on cars, while the cartridges are carried to it. The gun has no armor shield, as it is protected in the lowered loading position by the parapet. The barrel is exposed only for a moment while the shot is fired over the parapet. This time of exposure is so short that the barrel cannot be hit by aimed fire. The moment that the gun appears in the position for firing the shot is discharged automatically, whereupon the barrel is instantly lowered and disappears.

The 15-centimeter gun "L/40" (Fig. 6).—The cradle with the gun-barrel rests in a center-pivot carriage with pivot fork, constructed like that of the 19-centimeter naval gun. The cradle is provided with a kind of embrasure shutter which closes the opening of the embrasure in the shield so that no shell fragments nor shrapnel balls can penetrate into the interior.

A remarkable feature of the gun-barrel is the breech-block, provided with a screw in which the threads are formed in series of steps. It is an established principle of Krupp to give preference to a wedge-block which he has developed to high mechanical perfection. However, the 15-centimeter gun exhibited shows that he produces also a screw closure which surpasses foreign constructions as regards the simplicity of its mechanical arrangement. This screw closure has a

The sighting apparatus is arranged on the left side of the cradle.

(To be continued.)

A NEW SWISS HYDRAULIC PLANT.

ONE of the newest of the Swiss hydraulic plants is that which transmits power from St. Maurice to Lausanne, and it has the peculiarity of using a direct-current high tension line instead of the usual three-phase system. The power is taken from the Rhone and the rapids, affording 15,000 horse power, are utilized; the latter are situated near St. Maurice, a small town on the Jura-Simplon Railway. Before putting in the plant the different projects were examined by a commission of engineers, and it was found that the direct-current system devised by M. Thury would be the most economical and it was accordingly installed. The plant has been finished and was opened last May. At present the current is mainly used in Lausanne for light and power, but will also transmit power for the various industries of the region. The water is taken above the Bois Noir Rapids, and the dam allows for a total fall of 114 feet at low water. The dam is 296 feet long and is divided by masonry piers into three sections. The central section, 156 feet long, is movable and independent of the bed of the river. It has a set of movable vanes which rest upon a masonry construction in the bed of the Rhone. From the left-hand section leads a regulating canal, and from the right the main canal of the station. The latter is two miles long and comprises an upper canal, a deposit basin and a lower canal. The upper canal is 2,600 feet long and follows along the Rhone, only separated by a large masonry dike. It enters the deposit basin, which allows the sand and mud to settle; the basin covers an area of 4,000 square yards. From here leads the lower canal which is part open and part in tunnel. It passes under the Jura-Simplon Railroad and under the two beds of the St. Barthelemy torrent and arrives at the supply reservoir of the station, which has a capacity of 18,000 cubic yards. Here the water is further cleared and passes to the turbines by a penstock 9 feet in diameter resting on masonry pillars. The station contains two three-phase turbine-and-dynamo groups for the lighting of St. Maurice and five large direct-current groups for the transmission line to Lausanne. The latter give 1,000 horse power under a 104-foot fall. Each turbine drives two Thury dynamos of 340 kilowatts, making ten in all. The current is transmitted to Lausanne, a distance of thirty-four miles, by a high-tenison line using 2,200 volts. At Lausanne has been erected a large station in which the current is received and transformed by a series of

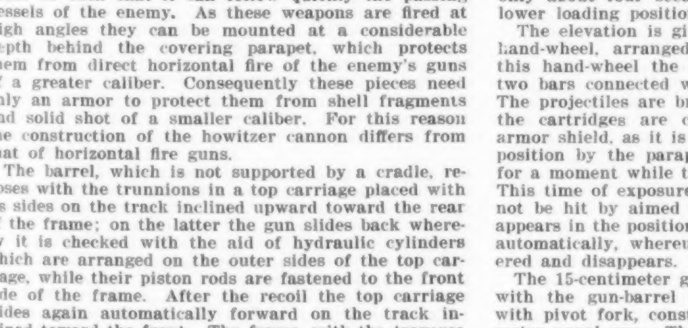


FIG. 4.—28-CM. HOWITZER "L/12" MOUNTED IN CENTER-PIVOT COAST-DEFENSE CARRIAGE.

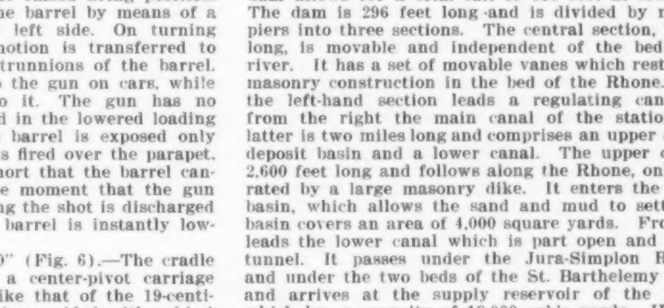


FIG. 5.—21-CM. GUN "L/40" MOUNTED IN CENTER-PIVOT DISAPPEARING CARRIAGE.

motor generators to three-phase current for the city distribution, as well as a 500-volt direct-current for the tramways.

A NEW FORM OF DIAPHRAGM CELL FOR THE ELECTROLYTIC PRODUCTION OF ALKALIES AND CHLORINE.*

By John B. C. Kershaw, F.I.C.

Diaphragm cells for the electrolysis of solutions of sodium or potassium chloride have been patented in the past by many inventors, and at the present moment four types of diaphragm cell are in actual use. The oldest and most successful of these is that operated by the Elektron Company, of Frankfort, since the year 1890. Very few details have been allowed to leak out concerning the construction of this cell, but Haber states that the diaphragms are of cement and that they have a life of two years. The Elektron cell has been widely adopted for the manufacture of alkali and bleach, and there are now eleven electrolytic alkali works in Europe using this type of cell.

The Le Sueur is the next oldest type of diaphragm cell, having been operated at Rumford Falls, in U. S. A., since 1892. The Le Sueur cell is distinguished by a horizontal diaphragm placed in the lower part of the cell. According to Weightman the diaphragms in this cell are constructed of asbestos and last from three to six weeks.

The Le Sueur plant has recently been transferred from Rumford Falls to Berlin Falls, New Haven, (?) where 700 horse power is said to be utilized.

The third type of diaphragm cell is that known as the Hargreave's Bird. This differs from the two preceding types in the use of an unsubmerged cathode, the diaphragm and cathode being joined together to form the sides of the inner compartment of the cell which contains the electrolyte and anodes. The outer, or cathode compartments of the cell, are filled with steam, and this condensing on the wire gage cathodes removes the sodium hydrate as it forms. Portland cement and silicate of soda are used to make the diaphragms of this cell, and their life varies from 30 to 50 days—under normal conditions of work. The Hargreaves-Bird cell has been operated at Farnworth, Lancashire, since 1896, and at Middlewich, Cheshire, on a larger scale since the early part of this year.

The Outhenin-Chalandre is the last type of diaphragm cell to achieve industrial trial. It is the most complicated in design of those in actual use. It will suffice here to say that the diaphragms are made in tube form, and that the cathodes are placed within them, while gravity is utilized to remove the sodium or potassium hydrate as it forms, from the influence of the current. The Outhenin-Chalandre cell is in operation at Chevrés, near Geneva, and in France.

The diaphragm cell about to be described is patented in the names of Moore, Allen, Ridlon and Quincy, all of U. S. A., and the English patent is No. 4,269, of 1900. In many respects it closely resembles the Hargreaves-Bird type of cell, and should the Moore-Allen cell become of industrial importance the question of patent validity is almost certain to arise. Fig. 1 is an external view of the cell, Fig. 2 a sectional end elevation, and Fig. 3 a sectional side elevation. The cell consists of two end walls, a, a, rabbeted at their upper ends to receive two side bars, a^1, a^1, thus leaving the lower part of the sides of the cell open. The ends are secured to a bottom plate, a^2; and ends, side bars, and bottom are preferably constructed of slate. The open sides of the cell are closed by the diaphragm, b, constructed of asbestos, or some material that will permit free percolation of the electrolyte. On the outside of each diaphragm is the cathode, c, consisting of several layers of wire-cloth, or of a bed of steel-wool, sufficiently thick to hold solution by capillary action.

The diaphragm and cathode are bent under the bottom plate, a^2, and the cathode in this manner makes electrical contact with the iron tray, d, in which a number of cells stand. This tray serves two purposes—it acts as negative conductor for all the cells standing upon it—and it collects the sodium or potassium hydrate solution dripping from the cathodes. The top of the cell, f, is constructed of lead. The anode consists of a number of blocks of gas carbon, e, e, cast into a lead plate, e' (see Fig. 3). The chlorine gas liberated at the anode is conducted away through the glass dome, g, and the lead gas pipe, g'. The supply of brine to the cell takes place through a pipe, a^3, inserted in the end wall, and provision for keeping the electrolyte saturated is made by the use of a funnel trap at h. The iron plate, d, is provided with a channel along one side, d', and the solution of sodium or potassium hydrate flowing from a large number of these cells is collected by setting the plate on which they stand in a slightly inclined position.

The advantages claimed for the Moore-Allen cell are that no steam is required to remove the sodium or potassium hydrate from the cathode, that a fairly concentrated solution is obtained containing little undecomposed salt, and that the design and structure of the cell are simplified by dispensing with an inclosed cathode compartment.

The use of the glass dome on the chlorine exit of the cell is said to facilitate the technical oversight of the process, and to lessen the dangers arising from electrical short circuits by the lead of the chlorine collecting pipes.

Advantages one, three and four may, in the writer's opinion, be granted, but it is doubtful whether the second can be substantiated by the results of actual trial.

The wording of the paragraph of the original patent relating to the possibility of producing a solution of caustic alkali containing little chloride, at the cathode, is as follows:

"As the saline solution percolates through the diaphragm it is held in suspension by capillary attraction in the metallic sponge, free chlorine being given off in the interior of the cell at the anode, and caustic

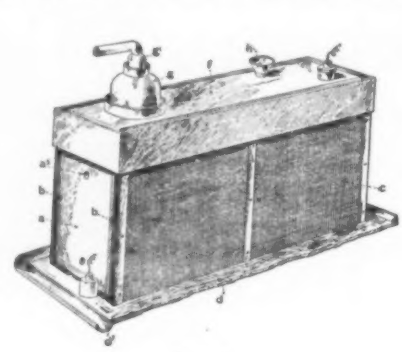


Fig. 1.

soda being formed in the cathode and on the surface thereof. As previously stated, the electrolyte percolates through the diaphragm, the sodium is set free on the surface of and in the cathode, uniting with the water of the solution to form caustic soda, or sodium hydrate. As the solution of caustic soda and sodium chloride trickles down through the sponge from edge to edge the electrolysis thereof is continued, and the balance of sodium chloride is converted by the water of the undecomposed solution in the pores of the cathode into caustic soda, the chlorine atom migrating through the diaphragm to the anode, and the resultant fluid reaches the plate, d, in the consistency of molasses, and consists of caustic soda and water with a minute percentage of sodium chloride, the sodium chloride, however, being in such small proportion that the solution given off is to all intents and purposes free from it for commercial use."

Leaving on one side the grammar and chemistry of this paragraph, which are alike open to criticism, the accuracy of the statement that a practically pure solution of sodium hydrate of the consistency of molasses can be obtained at the cathode of the Moore-Allen cell, under normal economical conditions of work, must be questioned.

It has been proved beyond the possibility of doubt that when a solution containing both sodium chloride and the hydrate is used as an electrolyte, the current shows an increasing tendency, as the electrolysis proceeds, to travel by the ions of the latter compound. Before the solution flowing from the cathode of the Moore-Allen cell had arrived at the degree of concentration, described in the above paragraph, the electrical efficiency of the cell would, therefore, have dropped to nearly zero, and the current would simply be decomposing the already formed sodium hydrate. It is for this reason that in all types of cell for the production of caustic alkali, the chief aim of the inventor is to remove the sodium or potassium hydrate as quickly as possible from the influence of the current, and in the type of cell most closely resembling that just described, this removal is effected by inclosing the cathode chamber and by injecting steam.

While, therefore, in some details of its structure the Moore-Allen cell may be regarded as an improvement upon types of diaphragm cell already in actual use, it must be held to be defective in one very essential point. Should the cell ever receive trial upon an industrial scale it will probably be found necessary to accelerate the removal of the caustic alkali from the steel wool cathode, either by a fixed spray of water or by some other means. Under the conditions described in the patent specification, the economic production of caustic alkali by this cell is impossible.—For our cuts we are indebted to Electricity.

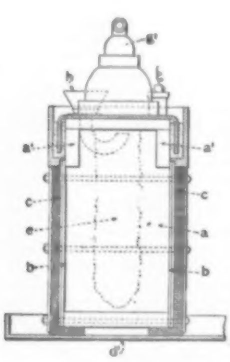


Fig. 2.

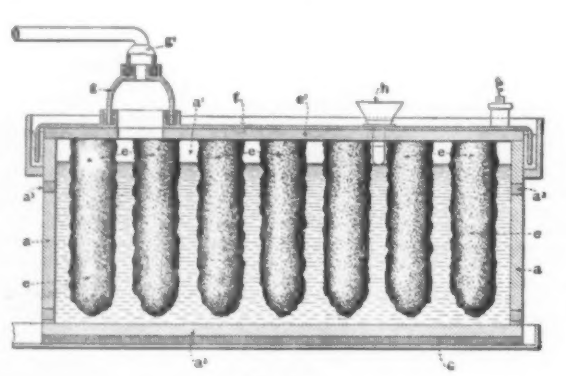


Fig. 3.

* From the Electrician, London.

CONTEMPORARY ELECTRICAL SCIENCE.*

Interference Tubes for Electric Waves.—A. Becker has made experiments with a view to determine the relative utility of two forms of Quincke interference tubes for measuring the length of electric waves. One of the forms consists of a tube with two branches, like a branched circuit, while the other has the shape of a T. In both cases the length of the wave transmitted by the tube does not depend upon the length of the tube, but upon its diameter. The wave length is about 1.6 times the diameter. The waves travel along the surface of the metallic tubes, and emerge into the air with a barely diminished intensity. The first form of interference tube acts as a polarizer, which only transmits vibrations which are parallel to the plane of the branches. If the stem of the T-tube is filled with insulating liquids, the wave length in the interior of the liquid may be determined, and a comparison of this with the wave length in air gives the dielectric constant of the liquid. The dielectric constant may be determined by two other methods, one of which involves the reflection of the waves by a mirror.—A. Becker, Ann. der Physik., No. 5, 1902.

An Optical Illusion in Vacuum Tubes.—A somewhat obvious but hitherto unnoticed phenomenon is the apparent luminosity of the outer glass wall of vacuum tubes when traversed by cathode rays. The only observer, says E. Goldstein, who has described this phenomenon, without, however, gaging the true nature of it, appears to have been Wiedemann, who said, in 1880, that the approach of a finger to the wall of a tube made the outer wall luminescent. Goldstein points out that the outer wall is, apparently, luminous whenever the wall of the tube is thin in comparison with its diameter. The optical illusion produced by a thin wall is the same as that which makes the water in a tumbler, or the mercury in a thermometer bulb, apparently penetrate the thickness of the glass, whereas the thread of mercury in the stem appears only slightly enlarged. A film of glass of red luminescence stuck on the inner wall of a tube, and struck by cathode rays, makes the outer wall apparently red instead of green. When the gas, and not the inner wall, is luminous, the rays from it do not undergo the refraction necessary to produce the optical illusion. This fact furnishes an important criterion to distinguish between canal rays, which only affect the gas, and cathode rays, which affect the wall.—E. Goldstein, Ann. der Physik., No. 5, 1902.

Calibration of Thermo-Couples.—D. Berthelot gives some valuable hints with regard to the use of thermo-couples in pyrometry. The cheapest and most satisfactory combination appears to be that of platinum with a 10 per cent alloy of platinum and iridium. The author believes that the anomalies sometimes encountered in the behavior of this and other couples are altogether due to a chemical change which they undergo in a reducing atmosphere such as exists in some parts of a Bunsen burner. In any case, these irregularities are never seen in an atmosphere of air, nitrogen or carbolic acid. Within the temperatures of 400 and 1,100 deg. the curve representing the relation between log (E. M. F.) and log T is practically a straight line. The fixed points used by the author are the melting point of zinc, 419 deg., and the melting point of gold, 1,064 deg. The latter is best applied by inserting a piece of gold between the elements at the hot junction, and taking the reading at the instant when the gold melts and thus breaks the contact. The melting point of sulphur, 445 deg., is not to be recommended unless the minute precautions prescribed by Heycock and Neville can be fully observed.—D. Berthelot, Comptes Rendus, April 28, 1902.

Scale of Periodicity.—A proposal of great interest to physicists and electricians concerned with the measurement of periodic motions of any kind is made by A. Guillemin. It deals with the choice of a standard interval. In acoustics, the standard intervals used are the octave, 2:1, and the comma, defined by the physicists as the ratio 81:80, and by the musicians as the ratio $3^{12}:2^{19}$. The author proposes the ratio 10:1 as the standard interval, and calls it the "savart." The logarithm of this ratio is unity, which means a great simplification of numerical calculations. Savarts would be measured by a logarithmic scale, and thus the "millisavart" would be the ratio whose log is 0.001. This ratio would be 435:434, and the natural definition of standard international pitch would be 434.3 vibrations per second. One "tone" would be approximately 25σ, the symbol σ being used for the millisavart, and Σ for the savart. The millisavart may be variously defined as the ratio of two notes giving one beat per second, or as the ratio between two periodicities differing by one vibration per second, or as the fraction 1.00230, whose log = 0.001. All these definitions are concordant. —A. Guillemin, Comptes Rendus, April 28, 1902.

Self-Electrification of the Human Body.—A. Heydweiller has made the interesting discovery that charges of opposite sign may exist on different parts of the body without giving rise to a neutralizing electric current. That all muscular activity gives rise to electric currents has been known since the researches of E. du Bois-Reymond, whose scientific fame mainly rests upon their elucidation. The author charges the needle of a quadrant electrometer to several hundred volts. One of the pairs of quadrants is put to earth, while the other is joined up to an insulated metal plate. If now one hand is held in the neighborhood of the plate, without touching it, and the operator mounts upon an insulated stand, the electrometer gives a considerable deflection, showing a negative charge of the hand, which only disappears slowly. The deflection indicates a charge of nearly 1,000 volts. This charge is not due to the friction of the clothes, as it is the same without. Bending the knee produces an opposite charge. The charges correspond in every case to the well-known muscular currents. But the novel observation is that these charges can exist for some time without neutralizing each other. This is attributed by the author to the existence of badly conducting layers in the epidermis. The energy displayed

* Compiled by E. E. Fournier D'Albe.

in producing these charges is very small in comparison with the mechanical work. The author puts it at about 250 ergs.—A. Heydweiller, Ann. der Physik., No. 5, 1902.

ABSORPTION OF BECQUEREL RAYS.—The absorption of Becquerel rays by gases imparts to the latter a conductivity due to ionization. Both Tommasina and Curie have recently found that the rays also increase the conductivity of liquid and solid dielectrics. It is, therefore, increasingly important to study the absorption of these rays by liquids. T. Tommasina has made a set of quantitative determinations which yield valuable material to work upon. He used the liquid electroscope devised by Curie, and measured the fall of potential without any liquid and with the liquid, and both again when a tube of radium-barium salt was introduced. Also the rate of discharge when the tube was surrounded by liquid to various depths. Thus, in the case of carbon bisulphide, the rate of discharge was originally four divisions. Introducing the Becquerel tube without a liquid increased the rate to 64.5. On introducing the liquid, the corresponding rates were 3.5 and 46.0 respectively, so that the carbon bisulphide absorbed about one-third of the rays. On adding a further thickness of 0.5 centimeters three times running, the rates fell to 23.3, 18 and 13 respectively, and on withdrawing both the liquid and the rays, the original rate of about three divisions was resumed. There is, therefore, no after effect. The greatest absorptions were due to benzine and ammonia.—T. Tommasina, Comptes Rendus, April 21, 1902.

RADIATION SCALE OF TEMPERATURES.—M. Fery has devised a practical method of employing Stefan's law for the measurement of temperatures. The apparatus employed consists of a kind of telescope with a fluorspar objective, which concentrates the radiation upon a thermo-couple. The author has ascertained that the absorption of radiant heat by the fluorspar increases in proportion to the amount of incident heat at temperatures above 900 deg. Hence, the only noxious effect of the fluorspar is to reduce the sensitiveness by about 10 per cent. The lens is focussed for parallel rays, and an inner diaphragm is so arranged that a certain cone of rays only is received upon the thermo-couple, thus rendering the range independent of the distance of the hot body. A comparison between the new thermometer and a Le Chatelier pyrometer shows an error well below 1 per cent at temperatures from 914 up to 1,450 deg., the highest temperature measured. The indications are very rapid, the mass to be heated being less than a hundredth of a milligramme. The zero is also very exact and constant. The author has measured the temperature of the positive arc carbon by this instrument, and found it to be 3,490 deg.—Fery, Comptes Rendus, April 28, 1902.

MAGNETIC FIELD DUE TO ELECTRIC CONVECTION.—The lack of an explanation of the discrepancy still existing between the results of Crémieu and those of certain American and Italian physicists led A. Righi to make an appeal to mathematical physicists to fully investigate the problem of "an electro-magnetic field produced by a charge in uniform rectilinear motion on the other side of an infinite conducting plane." This special case presents the simplest and, probably, the easiest case involved, and has since been completely solved by Prof. Levi, who finds that the magnetic field is smaller on the other side of the plane than it would be were that plane not there. If the charge moves with a velocity equal to one millionth of the velocity of light parallel to an infinite copper plate 1 millimeter thick, the magnetic field on the other side is only 8 per cent of what it would be in the absence of the copper plate. It would be 49 per cent if the plate were of tinfoil 0.2 millimeters thick. This result shows that the screens used in all experiments on electric convection must have a pronounced effect upon the magnetic field observed if the moving charges are discontinuous. If the electric field does not change the effect of the screen is nil, and since the magnetic field of a current is not sensibly intercepted by a conducting screen, it follows that the electrons must move in the conductor in a practically continuous stream.—A. Righi, Physikal Zeitschr., April 15, 1902.

SHIP'S COMPASSES.—H. Meldau gives a summary of the guiding principles underlying the construction of the modern mariner's compass. It is now generally recognized that the only effective way of avoiding the disturbing swing of the compass needle is to increase the period of swing. The old normal compass of the Admiralty has a period of 18 sec., while the now almost universal Kelvin pattern has a period of 38 sec. The equality of mechanical moment about various horizontal axes is brought about by the subdivision of the originally single needle into several needles, mounted parallel to each other at various distances from the center of the rose. The moment of inertia of the latter is increased, after Kelvin's example, by placing the mass of the rose near the margin, the central portion consisting practically of silk threads only. Another successful method of providing the required steadiness is that of employing a liquid in which the needle floats. The liquid usually employed is a mixture of alcohol and water. The magnetic system has, of course, to be much stronger owing to the viscosity of the liquid. The quadrantal deviation by masses of soft iron can only be obviated by means of needle induction. In the German navy soft iron masses are attached to the compass box itself.—H. Meldau, Physikal Zeitschr., April 15, 1902.

ELECTROTHERAPEUTICS.—Madame B. Maurel gives an account of the service of medical electricity at the General Hospital of Tours as practised during the last six years. A special floor has been set apart for this service. There are four wards and a waiting room. One of them contains the old apparatus for treatments with induction coils and influence machines, comprising Wimshurst, Bonetti and Carré machines as well as "postes faradiques." The second ward is furnished with X-ray apparatus and high-frequency machines, together with an Oudin resonator. The third ward is set apart for gynecology, and the fourth for galvano-cautery. In the period of five years ending July, 1901, 717 cases were treated, 207 of which were sent for electro-diagnosis, while the rest consisted largely of cases of hemiplegia, rheumatism, uterine affections and constipation. The radiographs taken amounted to 217, and included cases of a revolver bullet lodged in the skull, and a child's gullet containing a sou piece. The authoress claims that, in spite of certain structural disadvantages of the establishment, the electro-medical wards offer all the facilities which can be expected of an hospital equipped in accordance with modern resources. The influence machines are employed for what is still called "franklinization."—B. Maurel, Arch. d'Electr. Med., April, 1902.

THE ONDOGRAPH.

FOR a few years past alternating currents have been playing a very important part in the electric industry, and it is therefore necessary to know the laws and rules that govern them. In the course of the first studies made in 1881 and the years following it was admitted that alternating currents had a sinusoidal form; but now, after a deeper study and since the applications of alternating currents have become more numerous it is often found that the sinusoidal law is at fault when it is a question of making tests of motors, arc lamps, etc. It is therefore necessary, before all, to have an apparatus that shall permit of practically determining, for industrial purposes, the form of the alternating current produced by any alternator whatever.

Up to a few months ago such an apparatus did not exist. Meanwhile, in 1881, M. Joubert in some studies upon magneto-electric machines employed the method of successive points, which consisted in putting in circuit a measuring apparatus at a determinate instant. He thus obtained a series of ordinates at different instants. In 1885 M. E. Hospitalier applied the condenser method for the study of M. Anatole Gerard's direct current dynamos. In 1891 M. Blondel devised the "oscillograph," an apparatus that permitted of photographically registering the periodic curves of alternating currents. Since that epoch several other apparatus have been devised by Messrs. Abraham, Drexler, Laws and Callendar; but, as before stated, up to a few months ago, a simple, portable apparatus that could be connected at any point with any alternating current circuit and give a continuous curve of the operation of the alternator did not exist.

Such an apparatus was devised a short time ago by M. Hospitalier, who styled it the "ondograph." The object of it is directly to register in ink, upon a band of paper, the curves representative of an electric phenomenon periodically and rapidly variable, such as electro-motive forces, intensities, differences of potentials, powers, etc. In order to obtain such a result it suffices to send successively into the helix of a registering galvanometer, once per period, a quantity of electricity proportional to a series of very approximate ordinates (about a thousand for a complete period). The galvanometer at every instant assumes a position of equilibrium corresponding to the ordinate and describes the period in 20 or 30 seconds, according to the frequency, while the paper of the registering apparatus is unwinding under a pen controlled by the galvanometer. The ondograph, to begin with, comprises a synchronous, alternating current motor, D, set in operation by the electric source, the periodical variations in the elements of which it is desired to trace. This motor actuates a train of gear wheels which in turn control an automatic coupler, F. The angular velocity of the automatic coupler is always slightly less than that of the motor. In this way there is obtained an inscription of the curve in the same direction as the passage of the time; and the necessity of causing the brushes of the coupler to revolve is avoided.

The automatic coupler is formed of a cylindrical core of insulating material carrying a copper tube against which bear three brushes. These arrangements permit of successively coupling a condenser (1) between two points, E, of the circuit in which the phenomenon to be registered is occurring; and (2) in the circuit of a measuring apparatus, B. The registering is done upon a cylinder, A, to which a proper velocity is directly given by the synchronous motor. In the first model, which served to trace more than 300 curves, the motor was a Blondeau continuous current arc excited separately by two accumulators, and the Gramme armature of which received the alternating current through two rubbers and two rings connected, respectively, with the two extremities of a same diameter of winding. This motor was supplied by a Gaiffe variable tension transformer. In the new model the synchronous motor operates at 100 volts without excitation. The motor is started by means of a winch, H, and is connected with the circuit as soon as a disk, C, formed of alternately white and black sectors, indicates a synchronism through its apparent immobility.

The ondograph may be arranged also for inscribing powers.

In Fig. 2 are shown three curves reproduced in facsimile from traces obtained with the ondograph, and which exhibit to us the laws of variation of the phenomena that occurred in three different alternators. The central curve (No. 2) is that furnished by the Ganz alternators of a new model that are operating upon the sector of the left bank of the Seine; the law of variation of the electromotive force is here very sensibly sinusoidal. Curve No. 1 was taken upon a circuit supplied by an old style Zipernowsky machine upon the sector of the left bank of the Seine. This curve differs much from a sinusoid. Finally, in No. 3, we find a flattened curve, of which the ordinate rapidly acquires a given value and keeps sensibly constant. This curve was furnished by an alternator with an undulating flow. It will be seen that the law of variation of the electromotive force differs greatly from the sinusoidal.

The ondograph would furnish us with further and more interesting observations should we pass in review the curves that have been obtained in circuits upon which there were voltaic arcs with homogeneous carbons, and coils with and without an iron core, and should we analyze the curves giving the measurement of power.

The above short description will serve to show the reader that the ondograph may prove very useful in the registering of the law of variation of different periodic phenomena. We can thus ascertain experimentally whether the laws that theory often gives without any basis and solely through more or less hypothetical calculations, are in reality applicable to the facts that result directly from experiment.—For the above particulars and the engravings, we are indebted to La Nature.

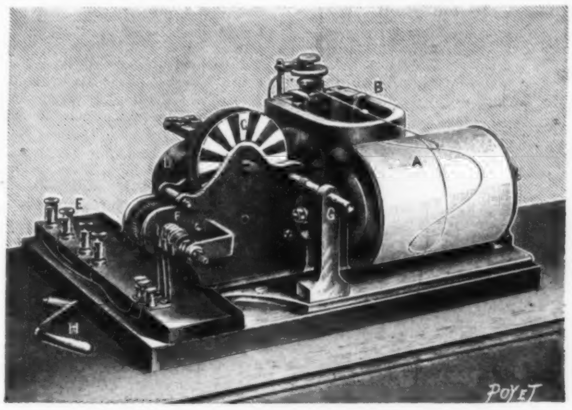


FIG. 1.—THE ONDOGRAPH.

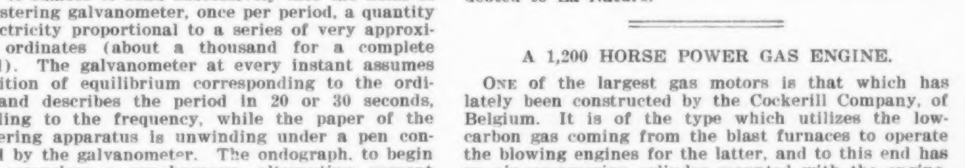


FIG. 2.—CURVES OBTAINED WITH THE ONDOGRAPH UPON DIFFERENT ALTENATORS.

1. Alioth alternator with undulating current. 2. New style of Ganz alternator. 3. Old style of Zipernowsky alternator.

A 1,200 HORSE POWER GAS ENGINE.

ONE of the largest gas motors is that which has lately been constructed by the Cockerill Company, of Belgium. It is of the type which utilizes the low-carbon gas coming from the blast furnaces to operate the blowing engines for the latter, and to this end has an air-compression cylinder mounted with the engine. The present engine is the largest which has been built by this firm, and develops 1,200 horse power. A number of ingenious devices had to be used to avoid the disadvantages inherent in a gas engine of such a large size. The two explosion-cylinders are placed in tandem, which permits of obtaining the advantages which characterize a 2-period cycle as to regularity of working, while assuring the simplicity of construction and absence of complication due to the 4-period cycle. A particularity of the tandem disposition is that the efforts which the movable parts have to support are not greater than in the case of a single cylinder, while the power is doubled. In the present engine the ignition is made by a spark-coil, and a small electric

motor is used for starting. The motor cylinders which receive the explosive mixture are 52 inches in diameter with 56-inch stroke. The shaft passes to the rear and enters the air-compression cylinder of the blower, which is mounted in line with the others and has a diameter of 74 inches. The blowing cylinder not only has the usual aspiration and exhaust valves of the air-compressor, but at each end has a series of large valves which open automatically at starting in order to facilitate this operation, or again, come into use when the air-pressure rises above a certain limit. The total weight of the gas engine, including the flywheel, is 260 tons; the latter weighs 36 tons.

THE RAPID AGEING AND FIREPROOFING OF WOOD.

THE preservation of wood was formerly accomplished by drying and covering it with coatings designed to prevent the entrance of air and moisture. These have given place to numerous plans for the introduction of antiseptic liquids.

The decomposition of wood occurs soon after it is felled and exposed, whether in logs or in pieces, to the air, moisture and variations of temperature. It is also destroyed by being buried in the ground or immersed in water. Cut up in planks and dried in the open air it warps and cracks, causing considerable loss. At 300 deg. C. all wood, dry or preserved by antiseptic liquids, is carbonized without production of flame, but subjected to a red heat, or to the action of a burning body, as in a fire, the pieces of wood are completely destroyed, even if they are covered with a coating opposing to the fire a certain resistance. Whence the multitude of processes made use of for more than a century for increasing its durability.

Let us consider in a few words what wood is, the properties of its principal components, and the causes of their rapid change.

Wood is formed essentially of two different substances, one predominating, the ligneous, and the other liquid, the sap.

1. The ligneous is formed of cellulose, that is, with reference to its elements, of carbon, oxygen and hydrogen. This organic tissue constitutes the framework of the plant, in the form of vessels and fibers, which are covered with an agglutinant organic matter (vasculose, cutose, pectose, etc.) The principal cause of the change of the ligneous is the great affinity of its carbon for its oxygen, an affinity favored by the changes of dryness and moisture, and finally resulting in the disorganization of the fibrous structure. The wood loses its power of resistance, the fiber is disintegrated and falls into a grayish powder.

Pectose and pectic acid, in the state of pectate of lime, form a part of the organic cement which binds together in bundles the cortical fibers of a great number of useful filamentous plants.

Pectose, like cellulose, is insoluble in all neutral solutions, but it has the property of conversion under different influences into soluble gelatinous products. Submitted to the double action of heat and of acids, it is transformed into pectine, a neutral, colorless body, soluble in water; then into pectic acid $C_{32} H_{48} O_{32}$ and quite a series of bodies increasing in acidity in proportion as they recede from their origin. These bodies may be presented in the following order: Parapectine, metapectine or parapectinic acid, pectonic acid, pectic acid, parapeptic acid and metapeptic acid.

2. The sap which fills the cellular cavities of the organic tissue is composed of a considerable quantity of water, holding in solution mineral and organic substances (nitrogenized, fatty and sugared). The sap passes by endosmose, and not by capillarity, from the soil into the roots; then circulates through the different parts of the plant, conveying various dissolved mineral substances, such as are found in the ashes. This liqdid, therefore, is one of the essential causes of the vitality of the wood. After it is cut down, the sap, undergoing the affinity of its carbon for oxygen and of its nitrogen for hydrogen, becomes a favorable medium and an aliment for the nourishment of worms and for the development of cryptogamic germs—additional and powerful causes of the changeableness of wood.

The sappy liquid represents a weight varying from 18 per cent in the yoke-elm to 50 per cent in the poplar.

Not only are the chemical and physiological causes of the changes of wood now understood, but a remedy has been found for the evil. It has been known for a long time that a dry wood is much less subject to decomposition than a moist wood, still impregnated with sap. This observation has led to submitting the wood before its employment either to natural or to artificial and rapid desiccation.

Until within the last few years the first method, the most simple, that of exposure to the air for a time, afforded good results, but the natural drying, which requires a good deal of time, especially for hard species and for considerable thicknesses, necessitates a very large surface for piling wood, and the loss by waste proceeding from splits at the extremities increases the price of dry wood. This explains the numberless methods for obtaining the rapid drying of the wood under the best possible conditions.

To describe all the processes would take us too far from the parts of the subject which we have in view. Paulet describes 173 methods, most of which have been patented, and which may be distributed in the three following groups:

1. By natural infiltration or displacement, applicable to standing wood or that recently cut down.

2. By pressure in the open air, applicable to wood in bark; or by pressure in an inclosure, applicable to dry wood.

3. By superficial application of antiseptic agents (by carbonization, immersion and coating) useful for all kinds.

Before considering the ingenious Nodon & Bretonneau process for the rapid ageing and fireproofing of wood, we will rapidly analyze the principal methods which have afforded material results.

In the first group may be mentioned *rafting*, which consists in immersing the pieces in water. This allows of drying the wood more readily, for the sap having been partially driven out by the water which has replaced it, this will evaporate more readily than the sap. For instance, oak for flooring, which would require two years of drying in the open air, may be dried in four months after having been subjected to the action of the water.

Wood is immersed in a stream or basin for three or four months. If the circumstances allow of raising the temperature of the water to 30 deg. C., the time of the operation may be reduced to fifteen or twenty days.

Steam also affords good results, so far as the drying is concerned, but unfortunately the fiber is in part attacked and the wood is much less tenacious.

In the Leclerc process the operation is conducted by steam, followed by drying in a current of warm air. The wood is arranged in a close chamber of masonry and the steam, strongly distended, is brought in for forty-eight hours by perforated pipes. Under the action of the condensed water a part of the sap comes from the cells of the wood, and the other part is coagulated. Thus the result is not complete.

The wood is afterward dried by causing a current of warm air (30 to 35 deg. C.) to circulate in the same chamber, which requires a fortnight for planks of ordinary thickness. The wood is piled upon the open-work floor of the chamber, inclining it sufficiently to cause the sap to flow. Each piece is separated from its neighbors, which allows the air and steam to circulate freely over the whole surface. For drying, the warm air is introduced, at one time from above, at another from below, and alternately at one or the other extremity of the chamber. It is drawn in through the wood and drawn out by a ventilator working at the opposite extremity.

Boucherie's processes, which belong to the first and second groups, utilize at one time the vital osmotic force of growing trees; at another the infiltration of a liquid, or the displacement of the sap by this liquid, on the tree recently felled. In the first case, one or two saw cuts are made at the base of the trunk, or several quite deep holes. An earthen band, or a strip of cloth smeared with rubber, is placed around the base and communicates by a tube with a small cask containing any antiseptic solution not too concentrated. The sap, on rising in the tree, draws with it the liquid, according to the diameter of the capillary vessels. The tree receives the poison as it receives the nutritive element.

In the second case, if the tree is felled, it is placed in a position slightly inclined, and a leather sack as impermeable as possible is attached to the trunk and put in communication with a reservoir 10 or 15 millimeters above. The results are quite noticeable, but the process is incomplete, the penetration being irregular and the displacement of the sap almost nil in the heart of the wood.

In the Renard-Perin injecting process, the piece of wood is sawed off at the two ends perpendicularly to its axis. One of the extremities is covered with a sack of impermeable canvas, in which the solution is poured; the other extremity is connected with a metallic receiver, in which a vacuum is produced by the combustion of tow soaked with wood spirit, which completely closes the apparatus.

The aspirator brings from the capillary interstices the natural liquids which they contain. These are replaced with the solution under atmospheric pressure. The operation is repeated two or three times.

In general, the processes by pressure in an inclosure, belonging to the second group, are worked by means of cast iron cylinders containing the pieces of wood. In many cases a vacuum is produced at the outset in the cylinder containing one or several pieces; then the liquid is introduced under pressure for several hours.

A modification of the Boucherie and the Renard-Perin processes is the new process of G. Lebioda & Co., the injection of the wood in mass. The trunk or log is inclosed in a kind of cast iron autoclave able to support a pressure of 150 atmospheres. The liquid is injected by a pipe, under a pressure, which is gradually increased for a quarter of an hour, in the case of spruce, up to 100 atmospheges. The wood is surrounded by the liquid, which is kept at the same pressure as that entering. According to the inventor, the fibers of the wood would offer no resistance under this process. The liquid entering would act like steam in the Gifford injector. But in our opinion the liquid submitted to so strong a pressure would seek to pass out by the shortest path, and the wood would therefore be penetrated irregularly.

When the object is to dry wood rapidly by this process, the treatment is effected simply with water; the sap, according to the inventors, would be expelled from pieces 10 by 10 centimeters, which would be dried in four days, the temperature of the air of the dryer being gradually raised to 90 deg. C., the temperature at which charring commences on the fiber. As the apparatus used by Lebioda & Co. is more costly than that of the Boucherie and Renard-Perin processes the results must be similar, the sap contained in the capillary vessels not having time to be completely displaced by the osmose necessary for this exchange of liquids. Under these conditions of rapid treatment the osmose ceases in the heart of soft woods, and is slight in the whole mass of hard or resinous species.

The superficial carbonization, belonging to the third group, is valuable for hard woods, which cannot be impregnated with antiseptic substances. This treatment is of more durable efficacy. The charring is produced by a flaming jet, which, in the current of compressed air, forms a kind of blow-pipe and causes a strong disengagement of heat. The flame draws out the water contained in the superficial layers, dries the fermentable portions, carbonizing completely the external part, and produces a torrified surface about half a millimeter thick, almost distilled and impregnated with the products of this distillation, which are empyreumatic creosoted substances.

Drying with smoke, which is effected in a chamber of masonry, heated by the combustion of moist sawdust, which yields a thick smoke, renders the wood useless for many industries, on account of its disagreeable odor and the slight resistance of its fibers, which have undergone some change.

In fine, of all these processes, except that of Nodon & Bretonneau, which we will describe, none resolves in an entirely satisfactory manner the problem of the rapid drying of wood, or the complete penetration of antiseptic or fireproofing products.

RAPID AGEING OF WOOD BY ELECTRICITY.

Of the different processes hitherto employed Messrs. A. Nodon and A. Bretonneau, preserving only the best principles and inspired by the experiment of Daniel on the displacement of a globule of mercury by the electric current, have succeeded in utilizing electricity for modifying the constituents of the sap. By that physical force which at times produces such unexpected effects, they have introduced on the ligneous tissue a suitable saline solution, which, after rapid drying, secures for the wood resistance to putrifying agents. Daniel, in his interesting experiment, placed in a glass tube bent at its extremities and arranged horizontally, a globule of mercury immersed in acidulated water. He introduced the wire of a battery at one of the extremities of the tube, the other wire in the acidulated liquid at the opposite extremity, and observed the movement of the globule of mercury, which was displaced from the positive to the negative pole.

After several years of study on the modifications of the vital parts of the wood and on the arrangements to be adopted and the choice of the baths for treating the wood, MM. Nodon and Bretonneau have been able, by placing the wood between two electrodes of lead, to finally resolve the difficult problem of the artificial ageing of wood and fibrous substances. The company which operates this important discovery has erected a model factory at Aubervilliers.

The practical working of this process is quite simple. The apparatus serving for the electric treatment of the wood consists of vats of cement or wood rendered tight by a lead lining 1½ millimeters in thickness, and isolated from the bottom electrically by porcelain. The dimensions are 6 meters and 12 millimeters in length, 3 millimeters in width and 1 millimeter in depth. A copper coil, placed horizontally at the bottom of the vat, allows of heating the bath by means of steam brought in by a pipe, which is connected on the outside with the coil by joints easily taken apart in such a way that the temperature of the saline solution can be kept at about 35 deg. C. during the introduction and removal of the wood, and then isolating the coils and consequently the vat from the steam pipe.

The wood to be placed in the vats is arranged on the outside on movable platforms, a kind of open-work frame covered with lead from 1 to 2 millimeters in thickness, forming the first electrode. The logs may be treated before they are cut up, provided they are separated from the bark. The logs or planks are placed in piles on the platforms as nearly uniformly as possible, the different piles being of the same height, 0.70 at the maximum. The quantity, thus prepared, is raised on a turn-table by a windlass, the platforms having a series of hooks, allowing of their being suspended to an iron frame under the windlass. The wood is then brought over the vat and let down into it. The upper face of the wood is covered with the second electrode, formed of lead 1 millimeter in thickness, contained in a connected series of small porous vessels or compartments of wood; these are in size from 0.90 meter to 1.25 meters in length, from 0.75 meter to 0.90 meter in width and 0.10 meter in height, closed at the lower part by felt between two pieces of canvas beaten down and fastened on the sides of the frame under wooden lath kept in place by screws. Thus there is a receiver retaining the water that is poured in for assuring the proper contact of the wood and the lead, as well as of the canvas and the felt, which serve as an intermediate vehicle for the different components of the sap expelled from the wood during the operation. The lead of the different porous compartments is united and thus forms a continuous electrode, which is put in communication with one of the poles of the dynamo, the other pole being connected with the lower electrode.

The vat is then filled with the solution employed for the treatment of the wood. This may be antiseptic or formed of salts for rendering the wood uninflammable. That in use at Aubervilliers for the ageing of wood properly so-called is a solution of crystallized magnesium sulphate (80 parts water, 20 magnesium sulphate) heated to 35 degs. C. The wood is immersed in this solution, emerging from the surface only a few centimeters (3 to 8 centimeters), the lower face of the upper piece of each of the piles of wood being always moistened by the solution. This bath may be used indefinitely, provided it is regenerated by means of magnesium sulphate according to the density of the liquid or the percentage of the salt. About every month the bath is brought to the boiling point, in order to coagulate and readily separate the organic matters proceeding from the wood.

Before the solution of magnesium sulphate was employed other baths were experimented with, which were abandoned on account of practical objections, such as the deposit of resinous matter on the surface of the wood, which had to be removed by scraping and washing, or on the fiber itself, which too quickly dulled the tools employed in working the wood.

In the treatment with the magnesium sulphate the continuous current employed is 110 volts, but instead of being directed through the wood always in the same direction, a change is made every hour or every two hours, or half the amount of electric horse power necessary for the operation is passed from the top to the bottom, and then the other half from the bottom to the top.

The duration of the treatment by electricity is proportioned to the electric resistance of the wood, which varies according to its nature, its thickness and its humidity. As in the processes by injection, the operation is the more prompt and complete, whatever the species of wood, provided it has been recently cut down, that is, if the sap has not undergone modification.

The ageing of wood ' treatment in vats is completely terminated when six electric horse power or about 4,500 watt-hours have passed per cubic meter of wood. The time may vary from seven to fourteen hours, the intensity of the electric current being generally kept between four and six amperes, which is secured by increasing or diminishing the emergent part of the wood.

Phenomena Produced during the Electric Treatment.—According to Daniel's experiment, electricity produces in the cells of the wood movements of contraction and dilatation.

1. A part of the magnesium sulphate of the solution employed penetrates by electro-capillarity into the cells, which are more or less free from sap.

2. Under the influence of the electric current there is an osmotic exchange between the saline substances of the sap and the magnesium sulphate.

3. Electrolytic action on the ferments of decomposition and putrefaction contained in the wood.

4. Finally, and the most important point, the simultaneous electrolysis of the organic salts contained in the sap and incrusting matters of the wood and the magnesium sulphate. The electricity facilitating the contact of the reagents with the ligneous fibers, the salts and metallic oxide are deposited and united with this fibrous matter and fabrics are mordanted by alum. The ligneous fiber containing the phosphates which contribute to this precipitation is thus united and protected from the action of the air.

By the reversal of the direction of the electric current the acids formed coagulate the albumen, the nitrogenized matter being always accompanied with sulphur and phosphorus. The metal unites with these metalloids and the phosphides and sulphides formed, render the nitrogenized matter unfit for vegetable and animal life.

There is therefore a formation in the mass of the wood, under the influence of the electrolysis, of new mineral compounds stable and imputrescible, and this in a way much more complete than by any other process, preventing the ulterior development of the germs which cause the decomposition of the wood.

The action of the electric current in the process of the ageing of wood is therefore very important. Investigation with the microscope and the results of analyses demonstrate the penetration of the elements of this salt in the fibrous matter to the heart of the wood.

The different parts of the wood being of heterogenous constitution, the proportions of the elements found by analysis vary from one point to another. The results given below are the averages of analyses of samples taken from different parts of the same piece of wood.

Ash obtained by incineration: Oak not treated, 0.30 per cent; oak treated with magnesium sulphate, 0.90 per cent; gray poplar not treated, 0.28 per cent; gray poplar treated with magnesium sulphate, 0.82 per cent. By analysis of the ash of the gray poplar treated with magnesium sulphate, there are found 0.24 per cent of sulphuric acid, corresponding to 0.60 of crystallized magnesium sulphate; 0.55 per cent of magnesia, of which one part (0.10) corresponds to the 0.60 of the magnesium sulphate above, and the rest, 0.45 per cent, is in the free state or combined with the organic acids of the wood.

Drying of the Treated Wood.—After treatment, if the wood is in logs, it is cut up into lumber, according to need. After it is thoroughly soaked with water, it is left from 8 to 15 days under a shed for drying. For this purpose the pieces are piled on each other separated by two or more spruce lath, according to length, the thickness of the lath varying from 8 to 25 millimeters, according to the thickness of the pieces.

If sufficient space is at disposal the wood can be left to dry entirely in the open air; still it undergoes the alternations of heat and cold and the irregularity of the action of the air. It seems, therefore, preferable, after a first drying without, to pile the pieces in a chamber, where a current of heated air is kept in constant circulation from two to eight weeks, according to the thickness, at a temperature gradually increased to 35 deg. or 40 deg. C. The wood is then thoroughly dried and ready for use.

Principal Advantages of the Artificial Ageing of Wood over the Process of Natural Drying.—If a piece of senilized wood and a piece of the same kind not treated and dried simply in the open air are compared under the microscope, it will be observed that the cells of the former have undergone contraction. The entrance of the air will therefore be rendered more difficult. Then the original albumenoid matters no longer existing, the wood will not be subjected to the influences of the hydrometric state of the air and may be preserved without change, escaping putrefaction and the attack of insects.

These properties have been proved by tests of the resistance, showing an increase of the tenacity of the fibrous matter. Experiments made by the superintendents of wood paving in the city of Paris have attested conclusively the penetration by this process. Pavements of senilized beech and pavements of beech simply creosoted have been laid in several quarters, particularly at the Porte Saint-Martin. When taken up some time afterward, the treated beech showed no sign of the usual putrefaction and exhibited more resistance to wear than the beech not treated.

By ageing the color of the wood is not modified and its sonorousness is increased to such an extent that it is now sought for by the makers of instruments of music.

This process not only imparts to the wood the qualities that have been enumerated, but causes an important saving over the methods hitherto employed, especially over that of drying in the open air, in the diminution of the capital represented in the value of the wood and in the land occupied, and in the prevention of waste.

It is not only applicable to the rapid drying of wood, but it allows of modifying the conditions of treatment, of increasing any one of the qualities previously cited, according to the kind of wood and the use to which it is to be applied; it is to be observed that for wood of close fiber the phenomenon of endosmose is weaker than for wood of loose texture, while the phenomenon of exosmose still preserves its value.

For instance, in ageing wood in a bath of sodium phosphate and borate, the durability of the wood may be augmented. With the aid of zinc sulphate a quantity of salt may be introduced in the fiber of the wood varying with the strength of the solution and the duration of the treatment. A resisting power will thus be imparted to the wood, permitting its employment with success concurrently with creosoting for paving, railway ties, draught vehicles, telegraph posts and other purposes.

Finally, by the electric treatment the uninflammability of wood may be increased by employing, for example, ammoniacal salts.

FIREPROOFING OF WOOD.

Strictly speaking, it is impossible to render wood completely incombustible, but an almost absolute immunity against the attacks of fire can be imparted.

Gay-Lussac was one of the first to lay down the principal conditions indispensable for rendering organic matters in general, and wood in particular, uninflammable.

1. During the whole duration of the action of the heat the fibers must be kept from contact with the air, which would cause combustion. The presence of borates, silicates, etc., imparts this property to organic bodies.

2. Combustible gases, disengaged by the action of the heat, must be mingled in sufficient proportion with other gases difficult of combustion in such a way that the disorganization of bodies by heat will be reduced to a simple calcination without production of flame. Salts volatile or decomposable by heat and not combustible, like certain ammoniacal salts, afford excellent results.

Numerous processes have been recommended for combating the inflammability of organic tissues, some consisting in external applications, others in injection, under a certain pressure, of saline solutions.

By simple superficial applications only illusory protection is attained, for these coverings, instead of fireproofing the objects on which they are applied, preserve them only for the moment from a slight flame. Resistance to the fire being of only short duration, these coatings scale off or are rapidly reduced to ashes and the parts covered are again exposed. It often happens, too, that such coatings have disappeared before the occurrence of the fire, so that the so-called remedy becomes injurious from the false security occasioned.

We will cite some formulas still recommended. They are applied:

1. By immersion or by imbibition.

2. By application of successive coats by means of a brush.

1. For immersion or imbibition the following solution is advised: Ammonium phosphate, 100 grammes; boracic acid, 10 grammes per liter; or ammonium sulphate 135 grammes, sodium borate 15 grammes, boracic acid, 5 grammes per liter. For each of these formulas two coats are necessary.

2. For application with the brush the following compositions are the best:

a. Apply hot, sodium silicate 100 grammes, Spanish white 50 grammes, glue 100 grammes.

b. Apply successively and hot; for first application, water 100 grammes, aluminium sulphate 20 grammes; second application, water 100 grammes, liquid sodium silicate 50 grammes.

c. First application, two coats, hot; water 100 grammes, sodium silicate 50 grammes; second application, two coatings; boiling water 75 grammes, gelatine white 200 grammes; work up with asbestos 50 grammes, borax 30 grammes and boracic acid 10 grammes.

Oil paints rendered uninflammable by the addition of phosphate of ammonia and borax in the form of impalpable powders incorporated in the mass, mortar of plaster and asbestos and asbestos paint, are still employed for preserving temporarily from limited exposure to a fire.

In England, America and in Paris attempts have been made to introduce, under strong pressure, preserving solutions into fibrous substances. Even large establishments have been erected in different countries for this purpose. Unfortunately this process by pressure is still attended with the serious evil of introducing fireproofing products only in the outer part of the wood, the solution reaching but quite a limited depth. The process consists in removing from the wood, with the aid of steam under pressure, a part of the liquid products which it contains, which excites a sort of distillation of the inflammable products, for which solutions are substituted, generally composed of ammonium sulphate or phosphate, boracic acid or alkaline borate.

The best result has been obtained by the electric penetration of the salts. In the Nodon & Bretonneau process fireproofing products have been introduced through the whole mass of the wood, and this in a way much more regular than by injection even under strong pressure. A power of resistance to the attacks of fire truly exceptional has been thus imparted. The quantity of fireproofing products depends on the concentration of the bath and the duration of treatment.

It has been ascertained by experiment that wood is really uninflammable; that is to say, that it resists for quite a long time a very high temperature, if it contains, according to its nature, from 15 to 20 per cent of the salts employed.

FIREPROOFING OF WOOD BY ELECTRICITY.

The successive operations and the apparatus for incorporating the fireproofing salts in the mass of the wood are nearly the same as those for the ageing of wood properly so-called. It is absolutely necessary for the treatment that the wood should be both green and not too hard. The penetration of the salts being effected in great part by osmose, the sap is an important factor, and a hard wood would be difficult for the introduction of a quantity of preserving substances.

The vats employed are on the average 4.50 meters long, 1.50 meters wide and 0.70 meters deep. They may be of cement or of wood, lined with lead, like those used for ageing with magnesium sulphate, but the solution of ammoniacal salts is heated by a worm of hardened lead, instead of copper, in which the steam circulates.

At each of the extremities of the vat is a vertical partition of lead perforated with holes, forming a kind of reservoir, 0.25 meter wide by 1.50 meters long (the width of the vat), in which are poured the fireproofing salts necessary for maintaining the solution at saturation.

The wood is piled upon the lower electrode to a height of 0.15 meter to 0.20 meter at the maximum and covered with porous vessels containing the second electrode. The fireproofing bath employed is a saturated solution at the temperature of 80 deg. C. of ordinary ammonium sulphate and ammonium borate.

The electromotive force of the electric current utilized ought not to exceed 25 volts. The electricity passes into the wood always in the same direction from below afterward.

According to numerous tests which have fixed the constants of the electric treatment the best results are obtained with an intensity not exceeding 12 to 16 amperes per stere of wood; that is to say, that the electric energy necessary is about half an electric horse power per stere in treatment.

The total duration of the operation is 48 hours, divided into two equal parts. At the end of the first period, the wood is reversed (turned upside down). The wood thus treated has absorbed from 15 to 20 per cent of its weight of the salts of the bath. These salts penetrate to the heart of the cells and form a sheath around the fiber. If the wood after drying is submitted to the action of fire, the ammoniacal salts, which encompass the fibers, melt. On increase of the heat, the fibrous matter is carbonized slowly and the gaseous products resulting from the decomposition of the salts prevent the ignition of the combustible products proceeding from the calcination of the fiber. In a word, the fire is limited to the points attacked and is not propagated to the neighboring fibers.

The official tests conducted at Paris by the fire department are conclusive. On the application of the officials, the inventors constructed a number of cubic boxes, 0.50 meter in size, of spruce and poplar fireproofed planks 26 millimeters in thickness; the bottoms of the boxes were perforated with five holes. One of the boxes was filled with a kilogramme of dry shavings, which, when set on fire, required five minutes for consumption. A large amount of heat was developed. After the combustion, it was found that the outside walls of the box had remained cold, and that the inside had not been charred beyond the thickness of 1 millimeter. No point remained on fire and no part of the wood was separated under the influence of the extreme heat.

The second box contained a double weight of shavings, which were thirteen minutes in burning. When the combustion was completed, it was found that the interior of the box was red with heat, but without flame.

The third experiment took place with a fireproofed box of white wood, in which three kilos of shavings were burned. The test lasted for 30 minutes; the interior was incandescent and the wood charred for five or six millimeters in depth, while the exterior was simply heated.

Another test with a spruce box not fireproofed, containing 1 kilogramme of shavings, ended in three minutes in a small conflagration, which had to be extinguished with water. These results are conclusive.

A piece of fireproofed wood submitted to the action of the electric spark is simply carbonized at the parts of contact, while wood not treated bursts quickly into flame.

The curious tests on the resistance of certain building materials to fire, conducted before the representatives of foreign fire departments, may also be cited. A square construction of cement was filled with 7 or 8 steres of wood moistened with petroleum. It was furnished on one of its sides with an iron door, on its second side with a door of wood, fireproofed by this process, and on the third with a window of protected glass, that is, glass cast on metallic gauze. Wood piled up in this inclosure was set on fire and extinguished after the interior temperature had reached about 1,400 deg. The door of wood was consumed only after the lapse of one hour.

The iron door was very quickly put out of shape and allowed such a quantity of heat to pass that ordinary boxes placed at a distance of three meters were consumed.

This method of penetration furnishes complete security in other extreme exposures. The wood designed to receive electric wires may, by being previously fireproofed, avoid the serious accidents which frequently occur.

Wood thus rendered incombustible is imputrescible, its tenacity is the greater, but it can be readily worked. It can be glued perfectly and receive the painting or varnishing desired for preventing the penetration of the moisture of the air and avoiding completely the decomposition of the ammoniacal salts.

This new method of rendering wood incombustible, while materially augmenting its value, does not involve too large an expense. Experience, indeed, has shown that the cost of fireproofing by this process is less than that of other methods in use, and that the wood can be employed for numerous purposes, especially on war vessels, where metal has been hitherto used.—Translated from the Revue de Chémie Industrielle.

LUMINOUS BACTERIA.

J. E. Barnard has been investigating the conditions under which light is emitted by certain micro-organisms, which occur principally, if not entirely, in sea water. In fluid cultures they apparently respond to any agitation or excitation so long as the supply of oxygen is maintained, and they can also be kept in a luminous condition if oxygen be continuously applied, even though they may remain at rest. In artificial cultivations these so-called "phosphorescent" bacteria grow best on a medium containing a considerable proportion of a soluble chloride in addition to the nutritive material. They will grow on an ordinary peptone-beef-broth gelatin medium, but all of them do not then emit light, and they do not emit the maximum amount they are capable of producing. The best results are said to be obtained by adding to the culture medium 2.6 per cent of sodium chloride, 0.075 per cent of magnesium chloride, and 0.3 per cent of potassium chloride. In the case of fluid nutrient media some means must be taken to replenish the oxygen, as the amount held in solution is speedily exhausted. If free oxygen be allowed to bubble through the medium very brilliant cultures can be obtained, but frequent agitation can also be resorted to as a means of introducing

fresh oxygen. The temperature at which the organisms grow is variable. Those found in northern latitudes can grow and remain luminous at 0 deg. C., the optimum temperature being about 15 deg., at which reproduction is very rapid and luminosity at its maximum. Some organisms found in the tropics grow, however, at a much higher temperature, but none of them have an optimum as high as blood-heat, 37 deg. C. Spectroscopically, the light emitted by these organisms is confined to a small portion of the visible spectrum, never extending into the ultra-violet or infra-red. Visually it only includes the green and blue, and photographically it extends very slightly further toward the violet.—Nature.

LOCOMOTIVES FIRED WITH PETROLEUM.

THE use of petroleum and its residue for the heating of boiler furnaces is quite widespread in the United States and Russia, two countries in which the petroleum industry has been extensively developed. The partial or total substitution of petroleum for the solid fuels that are employed in locomotives is attended with advantages in certain cases, even in regions in which there are no oil wells and in which the cost of this liquid is consequently much higher than in those countries that produce it.

It is hardly necessary to recall the fact that the calorific power of petroleum is much greater than that of coal; that its combustion is much more uniform and complete; that the temperature of the furnace in which it is used can be properly regulated, and that the handling and storing of such a fuel can be more easily effected than when it is a question of supplying locomotives with coal or wood. In coal-producing countries it is impossible to think of employing petroleum except as an auxiliary; and so locomotive boilers in such cases must be arranged with a view to burning coal therein normally, and liquid fuel as an auxiliary in order to raise the pressure or to provide the engine with a greater amount of steam, when, for example, it becomes necessary to ascend a lengthy gradient or to traverse a long tunnel.

One of the most practical burners for employing oil fuel in the furnaces of locomotives is that devised by Mr. James Holden, engineer-in-chief of the State line for traversing the Arlberg tunnel, and the railroads of Burma.

In the accompanying figures we illustrate one of a series of eleven petroleum-fired locomotives built by the Great Eastern Railway Company for hauling heavy passenger express trains. The particulars and chief dimensions of these engines are as follows:

Cylinders	19 in. diameter by 26 in. stroke.
Wheels—	
Coupled driving wheels	7 ft. diameter
Bogie wheels	3 ft. 9 in. diameter
Wheel Base—	
Center of bogie to center of drivers	11 ft. 3 in.
Center of drivers to center of trailers	9 ft.
Center of bogie wheels	6 ft. 6 in. apart.
Total wheel base	23 ft. 6 in.
Frames—	
Total length of frames	30 ft. 7 in.
Distance between frames	4 ft. 1½ in.
Thickness of plate	1 in.
Boiler—	
Outside diameter	4 ft. 9 in.
Length of barrel	11 ft. 9 in.
Length of fire box (outside)	7 ft.
Width of fire box	4 ft. ⅛ in.
Number of tubes	274
Diameter of tubes (outside)	1¾ in.
Working pressure	180 lb. per sq. in.
Height of center line of boiler from rail level	8 ft. 3 in.
Heating Surface—	
Tubes	1516.6 sq. ft.
Fire box	114 " "
Total heating surface	1630.5 " "
Fire gate area	21.3 " "
Weights, in working order—	
On driving wheels	16 tons, 16 cwt.
" trailing "	16 " 5 "
" bogie "	17 " 0 "
Total weight of engine	50 tons 1 cwt.
" " " tender	35 " 1 "
" " " engine and tender	85 " 2 "
Tender—	
Water capacity	2,800 gallons.
Oil "	720 "
Coal "	30 cwt.

Materials—
Frames, straight from end to end, made of steel.
Boiler barrel and outer fire box, made of steel.
Inner fire box, made of copper.
Patent flexible stays (used throughout) made of Stone's bronze.
Tubes, made of copper.
Wheels, made of cast steel.
Axles, made of steel.
Coupling rods, connecting rods and motion generally made of steel.
Axle boxes, made of gun metal.
Tender tank plates, frames and stays made of steel.
Wheels, made of cast steel.

blast pipe is fitted, which enables the engine to work ordinarily with a blast orifice of maximum diameter, but provides facility for sharpening the blast when the engine is working under specially severe conditions.

The boiler is one of the most powerful at present in existence on English locomotives. Owing to the elevation of the boiler above the rails the smokestack is very short, but is prolonged into the smokebox. The firebox is of copper. Its top is strengthened by longitudinal steel stays, and its sides are connected with those of the firebox by flexible stays of Stone's bronze. The grate, which consists of two rows of slightly inclined bars, is surmounted by a brick dome.

The engine is equipped with the Westinghouse brake. The compressed air reservoir is formed by the hollow platform upon which the engineer stands. The brake pump is provided with an automatic pressure regulator.

THE COMPLETION OF THE SAULT STE. MARIE CANAL.

AFTER four years of work and an official expenditure of $5,000,000 the great Soo Water Power Canal, the finest engineering work of its kind, has been completed. The new passageway is deep enough to float the biggest vessel that sails the lakes. The canal is 2 1-3 miles long from the mouth of the intake above the Rapids to the overflow. The average width is 224 feet, and the depth is 22 feet. The intake has an area of more than 150,000 square feet, through which will flow a volume which is estimated to be 30,000 cubic feet per second, with a velocity of about 2 feet per second, or about 1½ miles per hour. The entrance is 891 feet wide and 18 feet deep. In its excavation some 300,000 cubic yards of material were removed.

At a point about 1,000 feet east of the entrance the intake merges into the canal proper. The cross-section of the canal at this point measures 4,425 square feet. For a distance of 4,100 feet from this point the canal is cut through solid rock. In cutting out the channel through this rock formation the sides were first cut out by channeling machines. The rock was

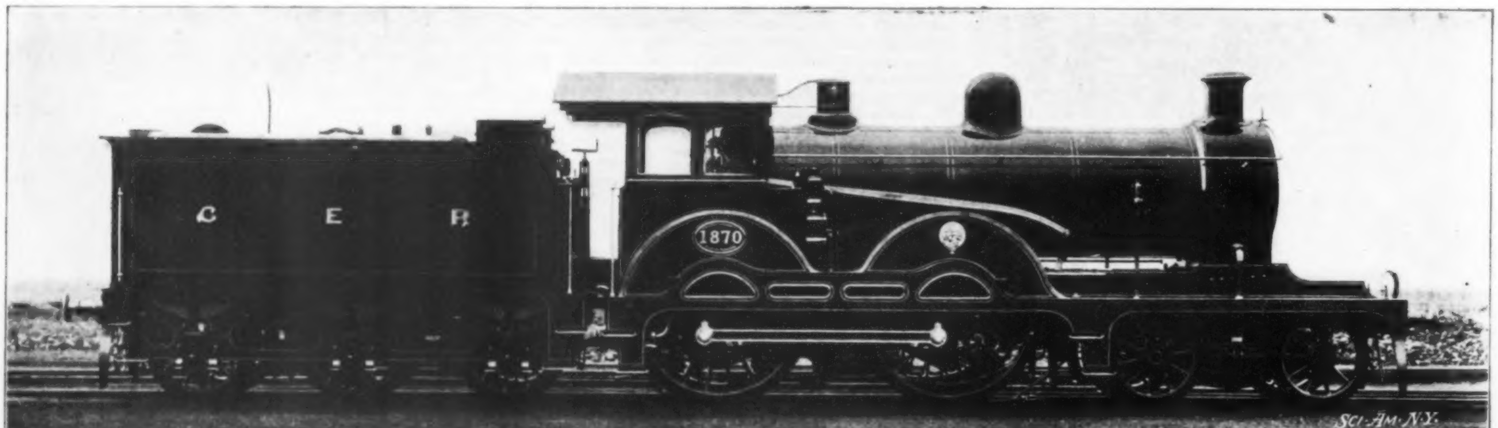


FIG. 1.—FOUR-WHEELED PASSENGER EXPRESS LOCOMOTIVE OF THE GREAT EASTERN RAILWAY. FIRED WITH OIL FUEL.

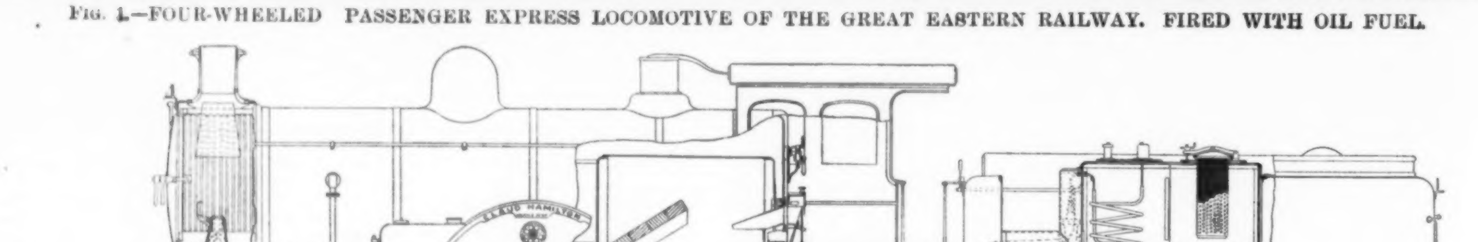


FIG. 2.—LONGITUDINAL SECTION.

Great Eastern Railway of England. Briefly stated, in this system the burners, which are generally two in number, are placed on the front of the firebox about a foot above the grate. The oil fuel is atomized through the action of steam, which is injected into an annular blower and which at the same time produces a suction of air that has been previously heated by passing through a heating device placed in the smokebox. As the ignition of the hydrocarbon can take place only at quite a high temperature, it is important that the putting of it under pressure shall be effected by means of a coal or wood fire maintained in a thin incandescent layer, if the furnace is designed for mixed heating, or covered with crushed bricks for storing up the heat, if the firing is to be done with liquid fuel solely.

It is the densest and least volatile hydrocarbons that give the best results; but it is necessary in most cases to render these more fluid by heating them by means of steam coils previous to using them.

The Holden system has been applied by various railroad companies, among which may be mentioned the Compagnie de l'Ouest, upon the Paris-Saint Germain line, the Great Eastern, Central London, and Lancashire and Yorkshire of England, the Austrian

The engine is fitted with Holden's improved patent apparatus for burning oil fuel either alone or in conjunction with coal. The oil fuel carried in the tender tank is conducted to the engine by a flexible hose under the footboard, and, after passing suitable regulating gear, is sprayed into the firebox by two burners, or injectors, placed on the firebox front about twelve inches above the grate. Heated air is brought from a tubular heating device in the smokebox and delivered with the oil spray through the central cones of the burners. The spray is then thoroughly atomized and diffused, and atmospheric air is drawn in for combustion by the action of small steam jets arranged around a ring blower at the front of each burner. Prior to its passage to the engine the oil fuel is heated by being conducted through a tubular heating chamber kept hot by the exhaust steam from the air brake pump. The reversing gear of the engine is operated by compressed air or by hand, and the locking is mechanical. Compressed air is also employed to raise and lower the ramsbottom scoop, which is placed under the tender to take up water while running. On the left-hand side of the engine an exhaust steam feed injector is provided, while on the right-hand side there is a restarting live-steam injector. A variable

then drilled, blasted and excavated, and the sides wherever rough were smoothed off with Portland cement. The bed was similarly finished. The immense labor necessary to accomplish this can be scarcely comprehended. The appearance of the canal bed, before the water was turned in, was as smooth as the exterior of a stone building.

For the balance of the distance the canal traversed a formation of sand, gravel and clay, the excavation of which was not attended by such difficulties. From the point where the rock formation leaves off to the entrance to the power house the sides and bottom of the canal have been planked with the very best hemlock timber. At a point below the water line the timbering ceases, and the remainder of the sides is paved with rock. Above that the banks are sodded, and a row of trees recently planted at the company's expense borders each side of the great waterway.

The object of planking beneath the water is to reduce the friction, thus securing as large a fall as possible at the point where the water power is secured. The lower 3,000 feet of the canal is on a continuous curve of about three degrees. The construction of the portion of the canal which traverses earth necessitated the removal of 1,500,000 cubic yards of

material, and 15,000,000 feet of timber were used in the flooring and sides of the canal.

The canal in its course through the city crosses thirteen streets, and at the present time is spanned by five steel bridges, one more is under construction, and others are projected by the city for the future as business demands them. At the lower end the canal widens out into the forebay, or mill pond, for the purpose of securing sufficient frontage for the uniform distribution of the water to all of the turbines, which are installed along the river face of the forebay in the power house. Because of this expansion the water issuing from the canal will at once disperse and enter the turbines at a velocity of two feet per second.

The river front of the forebay is closed by the power house, the duplicate of which cannot be found in the United States. It is constructed of red sandstone, is 48 feet over a quarter of a mile in length, is 100 feet wide, and 125 feet high. The massive building sits upon a foundation of piles covered by log sills and caps and covered with Portland cement concrete to a depth of 3 feet. The cost of building this foundation alone represents a snug little fortune. The substructure consists of eighty-one masonry walls 100 feet long, 20 feet high and 3 feet thick. The stalls or pits thus formed, aside from supporting the building, serve to deliver the water from the turbines into the river.

The penstocks are all of uniform dimensions, 40 feet long, 15 feet wide and 20 feet high. The dynamos occupy space on the same floor on the river side of the power house. The floor above is used for machinery, which converts the energy of the water into electrical power.

The energy to be developed by this immense engineering achievement is estimated at 40,000 actual horse power, developed by 320 turbines of the McCormick type. Four of these turbines in pairs are placed in each penstock. All of the turbines are joined to one high shaft of pressed steel, and are housed in iron cases, leaving no openings save for the passage of water. The water enters the penstocks at a depth of 13 feet and passes through the buckets of the turbines, through the draft tubes below each turbine, thence into the pits and from there into the river. As the rush of water passes through the turbines the wheels revolve, which in turn revolve the big shaft, and thus the power is produced to turn the dynamos awaiting on the floor above.

The electrical equipment of the power house consists of eighty dynamos constructed by the Westinghouse Company. After converting the water power into electrical power the latter will be transmitted by feed wires to the doors of the various plants, which are either in course of construction or projected, and which are expected to use the power produced. Among other things, the power will be used to light the streets of the Soo and to propel its street cars.

An interesting side feature of the canal is the big movable dam constructed at the head of the canal to control the volume of water. This was built by the Detroit Bridge and Iron Company, and the completed structure, it is estimated, represents a cost of not less than $100,000. The dam is made up of four "leaves," 50 feet long and 28 feet high, suspended from and operating between piers and solid masonry. When the water is entering the canal freely these leaves are suspended, and when it is desired to stop the flow the leaves are lowered against a sill in the canal bed.

Still another interesting feature is the ice rack, which occupies a space just at the entrance to the forebay. This is designed to intercept the ice, logs or other obstructions which may find a way into the canal and divert them into a spillway through which they are conducted into the river.

One of the serious problems which confronted the engineers in planning the canal was the effect the opening of such an immense waterway would have upon the level of Lake Superior. Upon this problem the opinions of the very best engineers of the country were secured, and the result was the construction at the head of the rapids of what are known as "compensating works."

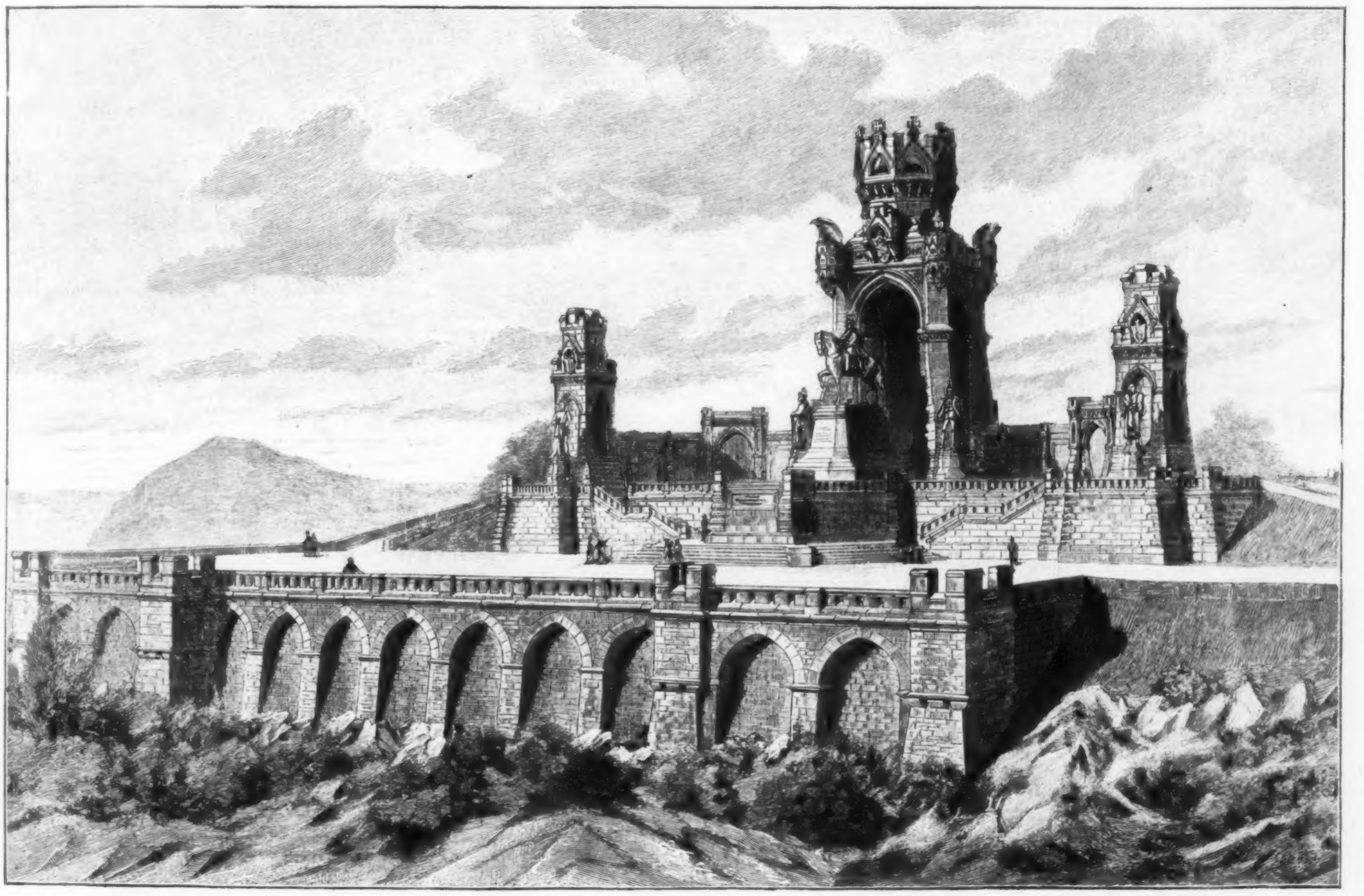
To compensate for the loss of water caused by opening a new outlet from Lake Superior which would discharge 30,000 cubic feet per second, twenty-four hours a day, 365 days in the year, a submerged weir or dam built upon timber cribs secured to the rock bed of the river, filled with concrete, with the weir of concrete upon this foundation, was constructed. These compensating works are located at the head of the rapids, just west of the international bridge.

THE KAISER WILHELM MONUMENT AT HOHENSYBURG.

THE proverbial fidelity of Westphalia to the fatherland has received another brilliant testimonial in the monument at Hohensyburg dedicated to the memory of Emperor William I. The origination of this is due to a local committee which, even at the time of the urgent movement in favor of the erection of a joint monument for the province, made a lively agitation for the most important of the mountains lying along the middle course of the Ruhr, and also later, after the Westphalian gateway (Porta Westfalica) at Minden had been selected by a resolution of the provincial assembly, undismayed, sought to attain the goal once set. The monument desired by these districts should be a memorial of the people for the people, and ought to find its resting place in the richest and most populous part of the country, within the borders of the old earldom of Mark, that part of the province of Westphalia which can boast of the longest adhesion to the Hohenzollern regime. Here is to be found the center of the industry and commerce of the province, and since this vicinity, in its rich profusion of magnificent, forest-clad peaks, rugged rocks, peaceful valleys, picturesquely situated ruins, castles, villages and cities, presents a most striking landscape, it was all the more to its honor to devote itself to an inspiring, patriotic work of art of a popular character. The sturdy and nature-loving inhabitants of the district perceived this readily and consequently the required money flowed rapidly and abundantly, and the committee, who, in the person of Adolph Overweg, owner of the manor house at Reichsmark in Westhofen, a man heartily inspired for the work, had secured a chairman who was as cautious as he was energetic, could advance the monument project most expeditiously, without in the least interfering with the efforts toward the erection of the Porta memorial in the northeastern part of the province. On May 28, 1893, in the presence of the highest officials of Westphalia, the cornerstone was laid with due ceremony. The monument is now finished, and on June 30 it was dedicated in the presence of the crown prince of Germany.

The edifice, which is built in the Gothic style, rises to a height of 546 feet above the level of the Ruhr and 750 feet above the sea upon a broad terrace, which upon three sides—those where the rocky walls descend abruptly into the valley—is supported by retaining walls and which afford standing room for 3,000 persons. A second terrace, somewhat smaller, lying higher up and reached by a broad flight of steps, forms the base for the monument. A tower, 100 feet in height, constitutes the central figure and on its front face shows a large recess, while its upper portion, which is octagonal, resembles a crown. Four prominent columns strengthen the corners of the tower and bear upon pulpit-like projections, four massive, brazen eagles. Above the arch of the recess is seen the escutcheon of the province of Westphalia, a prancing stallion; the corner areas cut off by the arch are adorned with oak leaves. Visible from afar, the tower serves principally to make the monument conspicuous from a distance, and, as the center of the whole figure, it is intended especially to set off the statues of the princes of the Hohenzollern house. In front of the recess arises upon a prominent pedestal, bearing the dedicatory inscription, the equestrian statue of Emperor William I., measuring twenty-one feet from the base to the tip of the helmet, and on the right of it the statue of the Emperor Frederick, and to the left that of Prince Frederick Charles. A semi-circular wall joins the middle tower on both sides with the two sixty-foot corner towers. Before these are seen the statues of Prince Bismarck and Field Marshall Von Moltke. The connecting wall is cut by arches, which later will serve as positions for the likenesses of other prominent persons of the great period. The breadth of the whole façade is 170 feet. Weatherproof black sandstone from the vicinity of Hohensyburg was used in the construction of the edifice. The plan of the monument comes from the royal architect in Hanover, Prof. Hubert Stier, who has performed his task in an artistic manner. In its simplicity and its grandeur, in the excellent execution of the particular details and the perfectly symmetrical arrangement of the whole, the structure with its bright yellow body of stone, its minarets, and the imperial crown above, makes a most striking impression. The statues were modeled by Prof. Adolph von Donndorf in Stuttgart; the casting was done by Gladenbeck Bros., of Berlin. The terraces of the memorial and the eastern approach offer not only a splendid view over the broad valley of the Ruhr, which at this point makes a juncture with the Lenne, its wildest and most beautiful tributary, but also furnishes standing room for great crowds of people and for the holding of patriotic celebrations.

The memorial receives especial consecration from the historical recollections of the most ancient times which are connected with Hohensyburg. In the year 50 B.C., the vicinity was inhabited by the Sigambrians, who built a walled city, Sigiburgum, on the mountain, and the name has with slight alterations been preserved with the ruins of the city until to-day. Charlemagne overthrew the Saxons in 775 after a severe struggle with Duke Wittekind. There when the great Frank strove for the privilege of becoming, as Roman



THE KAISER WILHELM MONUMENT AT HOHENSYBURG.

Emperor, the protecting lord of western Christendom, arises now, in the beginning of the twentieth century, in the midst of populous cities and romantic natural scenery, one of the most beautiful memorials to the honor of the founder and first ruler of a new and mighty empire.—For our engraving and the accompanying description we are indebted to Illustrirte Zeitung.

THERMOCHEMISTRY OF LACTIC ACID.*

LACTIC acid is one of the most important substances in organic and physiological chemistry. This acid and its nitrated and other derivatives play an essential rôle in investigations relative to animal heat. Yet its heats of formation and combustion are imperfectly known, having only been indirectly determined by an approximate numerical calculation from data obtained, not from the acid or from its salts, but from its ether. On this account we have taken up its thermochemical study, and this in three different ways, by means of silver lactate, zinc lactate and lactide, a very important anhydride, because it forms with the glycolide the prototypes of the anhydrides of alcohol acids.

The lactates of zinc and silver are particularly suited to this kind of research; on the one hand, by reason of the ease with which anhydrides are obtained, and on the other, because their combustion leaves for the one a pure metal, silver, for the other, a well defined oxide—a result which cannot be obtained for the salts of metals forming several oxides, or for the metals whose oxides remain, after combustion, in the form of basic or hygrometric carbonates.

I. PURIFICATION OF LACTIC ACID.—DILACTIC ACID.

1. The white lactic acid of commerce has a certain mixture of anhydride, or rather of dilactic acid. A quantity of this substance was weighed accurately in a small, thin glass tube having wide mouth; 5.9795 grammes and 6.9673 grammes of acid were used; 300 cubic centimeters of water were poured into a calorimeter, in which the tube with dilactic acid was immersed, and the tube was quickly crushed by means of a platinum crusher; 1 part of the acid was thus dissolved in about 50 times its weight of cold water, working at 15.7 deg. The heat disengaged was first measured, which furnished (average of two concordant tests) for one molecule $C_3 H_6 O_3$ . . . + 1.12 cal.

This estimate is probably slightly too high, the acid containing about one-sixth of anhydride, according to the results which followed.

2. The liquor, treated with an equivalent proportion of dilute potash (K O H = 2 cal.) set free + 11.06 cal., but the escape of heat was then prolonged gently. At the end of five minutes there was an elevation to + 11.96.

The limit cannot be reached in the duration of a calorimetric experiment. To arrive at the limit of the transformation, the aqueous solution of lactic acid must first be boiled for half an hour, or be left to itself for several months. Thus the normal value $C_3 H_6 O_3$ dil. + K O H dil. . . . + 13.5 cal. A considerable excess of potash hastens this result.

Glyceric acid, $C_3 H_6 O_4$, is another monobasic acid, with alcoholic function, presenting similar phenomena.

In reality, the dehydrated acid by simple evaporation has furnished, with a single equivalent of sodium, Na O H diluted, a heat of neutralization apparently equal to + 11.3 cal. raised after some minutes to + 13.1 cal. and by the addition of a second equivalent to + 13.4 cal.

These estimates confirm the received opinion, according to which glyceric acid is monobasic.

In general, as is well known, the alcohol acids have a tendency to form special anhydrides, designated *lactones*, and this fact has caused more than one error in their chemical and thermic study. In the case of lactic acid, a partial dehydration is easily produced, as Wislicenus and others have observed. This fact is much more essential than that it is converted into the formation of salts. In fact, if the lactic acid is neutralized after dissolving, these salts are often mixed with products less rich in metals, probably dilactates; this we have observed is especially apparent in silver salts.

To obtain pure lactates, the aqueous solution, freshly prepared by means of the concentrated acid, diluted with four parts of water, must be boiled for a certain period.

This boiling will also eliminate the mixed volatile substances if there are any.

II. SILVER LACTATE: $C_3 H_5 Ag O_3$ = 196.9.

Similarly, after cooling, we have prepared the silver lactate cold by means of the silver acid and oxide. The liquor is concentrated in a vacuum at the ordinary temperature, and in darkness to prevent complete decomposition. The salt crystallizes at a certain degree of concentration of the liquors. It is a hydrate. The water has been driven off by drying at about 80 deg. for three hours in darkness.

Analysis: Ag = 54.72; 54.77 — calculation: 54.75.

Heat of solution in 4.79 grammes (2 tests): (1 p. + 40 p. water at 12 deg.). Result, in molecular weight, 196.9 grammes; value 2.05 cal.

Heat of Neutralization.—This is measured indirectly by precipitation of the silver of the preceding salt dissolved in dilute chlorohydric acid (H Cl = 4 lit.) employed in very slight excess: two tests have given $C_3 H_5 Ag O_3$ diss. + H Cl dil. = Ag Cl precipitated + $C_3 H_6 O_3$ diss. . . . + 16.55 and 16.42. Average + 16.5 cal.; whence there results for one molecule $2 C_3 H_6 O_3$ dil. + $Ag_2 O$ = $2 C_3 H_5 Ag O_3$ diss. + $H_2 O$ . . . + 8.2 cal. Therefore heat of neutralization for an equivalent . . . + 4.1 cal.

The state of the hydration of the crystallized salt is difficult to define exactly, this salt easily losing a part of its combining water.

A salt left in the air a sufficient time contained Ag = 51.8 per cent, an approximate value of $C_3 H_5 Ag O_3$ $^2/_3$ H_2O. It must then have lost a third. Its solution in water has absorbed — 4.0 cal., that is, — 1.95 in excess over the anhydrous salt for $^2/_3$ H_2O: which would make — 2.6 cal. for the combining heat of one molecule of liquid water, H_2O.

Heat of Combustion.—The anhydrous salt has been subjected to the action of the calorimetric bomb, with the addition of camphor, of which account has been made in the calculation.

First test, 1.4226 grammes silver lactate (+ $^1/_3$ weight of camphor; second test, 1.369 grammes silver lactate + $^1/_3$ weight of camphor; third test, 1.3327 grammes (+ $^1/_3$ of camphor).

For one gramme of salt obtained: 1,620.2 cal.; 1,598.9; 1,610.0 cal.; average, 1,609.7 cal.

For one molecule (196.7 grammes) at constant vol. 316.6 cal., and consequently at constant weight, 316.5 cal.

Heat of formation deduced from preceding figures: $C_3 + H_5 + Ag + O_3 = C_3 H_5 Ag O_3$. . . . + 138.9 cal.

For the dissolved salt + 136.85 cal. From these figures are deduced:

Heat of Formation of Lactic Acid: $C_3 + H_6 + O_3 = C_3 H_6 O_3$ diss. . . . + 163.75 cal. For the pure liquid $C_3 H_6 O_3$, admitting the heat of solution found higher, which is about + 162.6.

III. ZINC LACTATE.

This is easy to prepare in the crystallized state, pure, and in the anhydrous state.

Heat of Solution.—5 grammes and 6 grammes of the salt were taken. Anhydrous salt (1 part salt + 100 parts water). From figures noted, molecular weight $(C_3 H_5 O_3)^2$ Zn . . . + 8.00 cal. Hydrated salt $(C_3 H_5 O_3)^2$ Zn, 3 $H_2 O$ . . . — 3.35 cal.

Heat of Hydration.—Liquid water: + 11.35 cal.

Heat of Neutralization.—By adding accurately diluted 2KOH to the diluted solution of zinc lactate $(C_3 H_5 O_3)^2$ Zn is freed: + 7.5 cal., whence $2C_3 H_6 O_3$ dil. + Zn O hydrated. . . . 27.4 — 7.5 = + 19.9 cal., that is, + 18.6 for anhydrous zinc oxide.

By the method of double reciprocal decomposition which is more exact: $(C_3 H_5 O_3)$ Zn diss. + $SO_4 H_2$ diss. . . . + 3.215 cal.; SO_4 Zn diss. + 2 $C_3 H_6 O_3$ diss. . . . + O. 125 cal. With $SO_4 H_2$ diss. + Zn O hydrated . . . + 23.4 cal.; thence 2 $C_3 H_6 O_3$ + Zn O hydrated. . . . + 20.06 cal. With anhydrous Zn O this would be + 18.76 cal.

Sulphuric acid almost completely displaces lactic acid, as generally in the case of monobasic organic acids.

Heat of Combustion.—About 1.2 gramme of zinc lactate is used with one-third its weight of camphor. The zinc remains in the state of oxide, which saturates the nitric acid formed in these conditions and condensed in the water, previously added, at the bottom of the bomb. The heat of combustion has been found for 1 gramme of anhydrous zinc lactate 2,580.3 cal.; 2,605.5; 2,590.4; average . . . 2,592.1 cal., or for molecular weight. 243.1 grammes at constant volume and pressure, 640.15 cal. Admitting Zn + O = anhydrous Zn O . . . + 84.8 cal.

Heat of Formation by the Elements.—2 ($C_3 + H_5 + O_3$) + anhydrous Zn salt . . . 355.45 cal. diss. salt . . . + 363.45 cal. From this is deduced: $C_3 + H_6 + O_3 = C_3 H_6 O_3$ diss. + 164.45 cal.; pure liquid acid . . . + 163.3 cal.

IV. LACTIDE: $C_3 H_4 O_2$.

This substance has been prepared in beautiful crystals by known processes and has been recrystallized in analyzed alcohol.

Heat of Combustion.—With 1.2402 grammes and 1.1909 grammes without adding camphor. For 1 gramme: 4.542.0 cal. and 4.543.6; average 4,542.8 cal. Whence for molecular weights, at constant volume and pressure, 72: + 327.1 cal.

Heat of Formation by the Elements.—According to preceding figures it is + 93.8 cal.

Solution.—The solution of lactide in 65 times its weight of water at 15 deg. has given rise, at first, to an absorption of heat almost instantaneous, or 0.79 cal. per molecule in one experiment.

But this absorption has been followed almost immediately by a disengaging of heat, indefinitely prolonged. After some minutes the heat thus freed rose to + 0.75 cal.; that is to say, almost equal to the initial absorption.

Evidently, the first change corresponds to the simple solution of the solid body, the second to its combination with the water; but the distinction between the numerical values observed can only be regarded as qualitative.

To complete the conversion, a potash solution in noticeable excess is added in such a manner as to gradually change the lactide into lactate. This operation has freed + 14.50 cal.; or, in entire operation, + 15.64 cal. This operation lasted more than one hour. It has been ascertained by adding to the liquor a percentage of diluted chlorohydric acid precisely equivalent to that of the potash, that the conversion was total, the heat disengaged being essentially that which would correspond to the percentage of potash employed in excess, over that which the lactic acid would have saturated. This verification is necessary and exact.

From these experiments the heat of hydration of lactide is deduced 15.6 cal.—13.5 cal. = + 2.1 cal. $C_3 H_4 O_2$ crystallized + $H_2 O$ + water = $C_3 H_6 O_3$ diss. . . . + 2.1 cal. For the pure liquid acid $C_3 H_6 O_3$, about 1.0 cal. conforming to that already observed for the glycolide.

Comparing the heat of formation of lactide by the elements with that of lactic acid, we have $C_3 H_4 O_2$ . . . + 93.8; $H_2 O$ . . . + 69.0; combination . . . + 2.1; total . . . +164.9. This last number, representing heat of formation of dissolved lactic acid, that of pure liquid acid will be about + 163.8. Thus:

	Dissolved Acid.	Pure Liquid Acid.
From silver lactate........	+163.75	+162.6
From zinc lactate........	+164.45	+163.3
From lactide	+164.9	+163.8
Average	+164.3	+163.2

It is noticeable that the hydration heat of the lactide is much lower than the conversion heat of the normal anhydrides, such as sulphuric and phosphoric anhydrides, the hydrogen carbides changed into alcohols, etc.

This indicates an interesting distinction in substances analogous to the lactide, notwithstanding the apparently incomplete character of similar compounds; a sort of *internal saturation*, which causes the greater part of the energy corresponding to the dehydration to disappear, and consequently brings their constitution near that of complete and saturated substances.

* From the French of MM. Berthelot and Delépine in the Annales de Chimie et de Physique.

THE CHEMISTRY OF COLOR.

SOME INTERESTING TRICKS AND EXPERIMENTS EXPLAINED.

THE ancients all believed that the world consisted of four elements—earth, air, fire and water. We know now, however, that each of these is actually composed of a number of different elements. The earth contains over 60. Water and air also contain a large number—three in practically constant proportions, and a number of others varying in quantity according to circumstances; while fire is merely the outward and visible sign of certain chemical actions.

The actual number of known elements is about 70, and nature has made each one different in color. Some resemble each other very closely, but there is a difference, apparent on examination, which becomes more strongly marked when seen through the spectroscope, or when each is brought into chemical combination with other elements.

A paper soaked in a solution of saltpeter and strontia and burned, imparts a rich crimson tint to the flame; one soaked in saltpeter alone, gives a violet tint. In the first case, the violet of the saltpeter is obscured by the crimson of the strontia, but the spectroscope separates both colors and enables them to be distinguished. The colored fires sometimes used in theatrical performances, etc., are instances of flames colored by different chemicals. Green is produced by, and is evidence of the presence of nitrate of barium or some other salt of that metal.

If spirits of wine, nitrate of copper, strontia and barium, and chloride of copper are boiled together and the steam ignited, four colors are seen—green, red, yellow and blue—due to the presence of the four chemicals mentioned. Sulphur when burned in the air gives a scarcely visible flame, but when burned in oxygen it yields a flame of a bright blue color. Oxygen gives brilliancy to burning sulphur and the effect of burning phosphorus in the gas is quite dazzling. The reason is that oxygen has a powerful affinity for other elements, and the process of chemical combination is frequently a violent one, causing both light and heat.

If hydrochloric acid (commonly known as "spirits of salts") is poured on oxide of manganese and gently heated, chlorine gas is liberated. This gas has a strong affinity for and will remove hydrogen from anything containing it with which the chlorine is brought in contact, changing the colors at the same time, even as hydrochloric acid will change the color of black cloth to red. The gas is very poisonous, but is easily mixed with water, when its properties may be studied with safety.

If this chlorine water is placed in a plate and covered with a bell-glass, a colored flower placed under the cover will shortly begin to lose its color, and will, after a while, become quite bleached. A quicker way of showing its actions is to put some into wine and ink. The color is speedily discharged. Put in one glass a little hydrochloric acid and in the other some ammonia. Each gives off a visible gas, but when the two glasses are brought together they are filled with a thick smoke, the invisible chlorine and ammonia combining to form chloride of ammonium. It has been ascertained that Italian air contains more chloride of ammonium than that of any other country, and Italy is said to owe its large percentage of singers to the effect of this chemical on the voice; an apparatus is, in fact, sold for inhaling it. A neat little bit of parlor-magic may be done with glasses charged in this way. Hold them apart, blow the smoke of a cigar between the two, bring the glasses together, pretending to catch the smoke, cover them with a handkerchief, and command the smoke to multiply, which it will do in true conjurer fashion.

Here is an interesting experiment. Red iodide of mercury is rubbed on a piece of paper with a cork and the paper is then held over a lamp until the red color disappears. A word may then be written on the apparently blank paper in blood-red characters with a piece of wood or anything else handy. The explanation is that heating the chemical melts and flattens the crystals, and when their shape is altered their color is altered also—a good illustration of the fact that the color of any article is not one of its inherent qualities, but is dependent entirely on its ability to absorb certain rays of light, and to reflect others. When the crystals are touched they are restored to their original shape and color. The effect of heat on color is made use of in magic inks. If a paper is written on with weak sulphuric acid, the writing is invisible; but on holding it over the lamp, the characters appear in black. The paper is charred, the corrosive action of the acid being developed by the heat. A more effective ink for invisible correspondence is a solution of chloride of cobalt. The writing done with this fluid is also invisible until heat is applied, when, it appears in blue, to disappear again, however, if it is simply breathed on. An application of the color-changing property of cobalt is to be found in window-panes painted with a solution of the chemical, or fabrics dyed with it. In dry weather the material is of a blue tint, but when the atmosphere becomes damp it acquires a pink color, a very neat barometer being thus formed.

One may produce some startling effects by sketching a winter landscape with a solution of bromide of copper. On heating it, it is miraculously transformed into a picture of spring, because the trees and grass were afterward painted over with muriate of cobalt, which turns green when heated, and the sky and water with acetate of cobalt, which turns blue. A conjuring trick introduced by the great Heller, and is somewhat similar in principle. The chemicals he used were different, but phenol and ammonia might have been used with equal success. On cards he had a number of ladies' names; one of the audience selected one and

retained it. Someone stepped on the platform, and he reproduced on his arm, without touching it, the name on the card. Of course, a few passes were made in front of it, and the aid of a few magic words invoked. The name then appeared on the arm, and it was seen to be the same as the one on the card. The explanation is simple. The cards all had the *same* name written on them. That name was painted on the arm beforehand with tincture of iron, which became invisible on drying. In his hand he held a little india rubber ball containing a solution of sulphocyanide of potassium, which he sprayed on the iron, producing the blood-red writing on the arm. A trick with the spray may be performed by anyone as follows: Sprinkle over a dry white rose some fine aniline dye (red by preference), then shake off the bulk of it. What is left will not be noticeable. Then spray some water on the flower and it will be transformed into a colored one, a very small speck of the dye being sufficient to color a quantity of the liquid.

To show the effects of color in analytical work, the following experiment may be performed. Take some solution of prussiate of potash; a little poured into a solution of sulphate of iron, turns it blue; poured into solution of nitrate of bismuth, the latter turns yellow; while solution of sulphate of copper turns brown. Again, look at the results of the mixture of the contents of these five test tubes. The first one, a colorless solution of iodide of potash, is poured into a solution of bichloride of mercury, also colorless. The result is the production of a scarlet color, owing to the formation of iodide of mercury. The third tube contains a solution of iodide of potash, which possesses the property of redissolving the iodide of mercury. When this clear fluid is added to the contents of the fourth tube, which contains oxalate of ammonium, a white chemical is formed, which is turned black as it comes in contact with the sulphide of ammonium in the fifth tube. Now, take a sheet of paper and write on it with some solution of sulphate of iron, a practically colorless solution, representing the river-water impregnated with iron. Now, if the writing is sponged with this solution of tannin it turns black at once, real ink being formed. This combination is utilized by conjurors. Blue ink may be produced in the same way, with two colorless solutions. On a paper any suggested word is written with the solution of iron. After drying it, a little solution of ferrocyanide of potash is sprayed on it. The result is to produce visible letters from invisible ones, a new chemical being formed by the combination of the other two, which is distinguished by a blue precipitate, as the tannate of iron is by a black.

Here is a conjuror's trick. We have two bottles filled respectively with ink and water, and desire to make them change places. They must be covered with a handkerchief and the conjuror's wand brought into play. We put in the corks, so that nothing can possibly be introduced into the bottles. The magic having worked sufficiently, we lift the handkerchief covering the ink, and we see that the ink is changed to water, with fish swimming in it to show that it is the genuine article. On lifting the other handkerchief we find that the opposite change has taken place—the water being changed to ink. The ink is produced, as you may guess, by having a little bottle of iron concealed in the cork and emptying it into the water, in which some tannin had been previously dissolved. Real ink might have been used for the other bottle and made colorless with oxalic acid or another chemical, but we could not then have displayed the fish; the bottle, therefore, was lined with black silk, which was withdrawn with the handkerchief.

Every one is familiar with the use that is made of blue in the laundry, but not every one stops to think of the reason why it is used. A bottle containing indigo is dissolved in dilute sulphuric acid and mixed with some carbonate of potash. The white cloth becomes blue, the red changes to violet and the yellow to green. The blue indigo dissolved in the manner indicated acts on the colors of the fabrics, one color blending with another to produce a third.

Another trick sometimes performed by conjurors is based also on chemical color changes. It is the pouring of a number of different fluids from one bottle. We will fill a bottle up with pure rain water. Then we will fill up the glasses, putting something different into each. The first is port wine, then comes sherry, then claret; now we have milk, now champagne, and ink. Into the last glass we pour water, to show there is no deception about this magic bottle. The magic was performed by a little iron previously put in the bottle and by small quantities of different chemicals put in the glasses, the iron acting on these developing the various colors.—The Spatula.

A CRITICAL REVIEW OF THE HIGH-SPEED ELECTRIC TRAINS AT ZOSSEN.

IN the SCIENTIFIC AMERICAN for February 8, 1902, and SCIENTIFIC AMERICAN SUPPLEMENT No. 1350, appeared illustrated articles concerning the high speed electric motor cars prepared for the Studiengesellschaft's tests on part of the Prussian standard-gage military railway between Berlin and Zossen. The tests having just been completed, partly to the satisfaction of the eminent electrical and other firms composing the Studiengesellschaft, a record thereof, taken from the elaborate report of Geheimer Baurat Lochner, should prove interesting to all concerned with either electric or steam railways. The negative results are in some sense equally important and interesting with the positive.

The first set of experiments was with speeds up to 100 kilometers (62 miles) per hour and low potential; the motors being switched out and the brakes applied when this speed was reached.

The second series of tests was made with regular speed of 100 kilometers, maintained at this minimum by means of resistances.

The third set was as in the first and second, only with higher potentials and speeds from 100 to 130 kilometers (62 to 80.8 miles).

In the fourth series there was employed a high potential and a speed of 130 kilometers (80.8 miles). The intention was to gradually work up to the higher speeds and potentials originally planned; the testing apparatus, rolling stock, permanent way and motors having been first proved capable of withstanding the less-exacting speeds and potentials.

The instruments of precision employed were as follows:

(1) Non-registering speed indicator for the motorman.

(2) Registering speed indicator.

(3) Apparatus for measuring increase and decrease of speed.

(4) Voltmeter.

(5) Amperemeter.

(6) Kilowattmeter.

(7) Apparatus for measuring the phase-displacement.

(8) Pyrometer for the temperature in the resistances.

(9) Air-pressure gages.

The car-speed register was checked each 500 meters by a wheel-speed indicator.

The braking speed being especially important, was measured by two registers and checked by the kilometer stones.

The cars were first "broken in" by a locomotive.

The section of road Berlin-Zossen is in one sense specially adapted to these tests, as it has no curves of less than 2,000 meters (6,560 feet) radius and no grades steeper than 1 in 200. The rails weigh 33.4 kilogrammes per meter (67.2 pounds average per yard), and rest partly on wooden, partly on iron ties; the bed is poor and mostly sand or gravel; but as a suitable track for the 23 kilometers (14.3 miles) would have cost about 500,000 marks ($119,000), this was used, after some betterment, with slag ballast, replacement of some of the rails and ties, and increase in the number of the latter. This answered up to 130 kilometers (80.8 miles) speed, but in the fourth series of tests, at 140 to 160 kilometers (87 to 99 miles), the track showed signs of distress. In the section between Mahlow and Rangsdorf the rails showed after the tests both lateral and vertical bending, almost without exception near the joints. This was because the joints had been stiffened for these tests with extra ties and ballast tamping; and as the middle of the rails gave, the intermediate parts, commencing at about the third or fourth tie from the joints, bent. In the stone-ballasted section near Lichtenrade there was much loosening of the old-fashioned screws and clamps which bound the rails to the ties.

At over 140 kilometers (87 miles) speed the cars swung sidewise most markedly, but in irregular periods; showing that the cause did not lie in the track.

The temporary condition of the track was measured by special apparatus such as are placed at intervals along the track, and in which vertical sheet lead templates exactly fitting the rail-profile, and stiffly supported independently of the rails, showed the amount of lateral and vertical displacement. The results showed that on a tangent the rails, even if not very securely fastened to the ties, were not much bent, and usually only vertically.

The vertical displacement was as follows:

UNDER ELECTRICAL CARS.

Distance between Tie Centers.		Material of		Speed per Hour.		Sinking of Rail.	
Mm.	In.	Ties.	Bed.	Km.	M.	Mm.	In.
850	33.5	Wood.	Sand.	108	67.1	2.0—2.5	0.08—0.10
850	33.5	Wood.	Sand.	114	70.8	3.5—5.	0.14—0.20
780	31.	Wood.	Slag.	145	90.1	6. —6.5	0.24—0.26
780	31.	Iron.	Sand.	114	70.8	5. —5.5	0.20—0.22
780	31.	Iron.	Sand.	135	83.9	6. —6.5	0.24—0.26
730	28.7	Iron.	Sand.	123	76.4	6. —7.	0.24—0.28

UNDER USUAL MILITARY TRAINS.

850		Wood.	Sand.	70—80	43.4—49.7	1.5—2.	0.06—0.08
730		Iron.	Sand.	70—80	43.4—49.7	4.	0.16

The short tests at 145 kilometers (90.1 miles) showed that the sinking increased with the speed, and was greater with iron than with wooden ties. At above 140 kilometers the increase was rapid and evidently caused increase in the jolting and slinging of the cars. No rails or fish plates were broken; breaks in the iron ties, found after the tests, were evidently old, and of the character familiar on steam roads.

Passing switches gave no cause for alarm; but there were sharp shocks on entering and leaving the 2,000-meter curves at Mahlow and Rangsdorf, showing that these require to be eased off at each end, and that the outer tangent rails must be raised sooner before reaching the curves. There was no sensible jolting at the rail-joints (probably by reason of the employment of six-wheel trucks, which are a comparative rarity in Germany).

The tests showed that it would be possible to double the present German railway speeds on well-built and well-kept lines of the usual type, with rails 42 kilogrammes per meter—85 pounds average per yard, and 18 ties to the rail of 12 meters (39.4 feet) in length. Derailment would be prevented by the use of guard-rails 50 millimeters (say 2 inches) higher than the regular rails. But on the present tracks a higher speed than 80 kilometers (49.7 miles) calls for stiffer car building.

The triple feeder line, which is carried by wooden masts, are of 50 square millimeters (0.0775 square inch) cross section; a wire of the same section unites the neutral point of the two transformers with the rails. This line ends in a safety appliance in a corrugated iron house; from here there is a cable.

The feeder-line remained in good condition, carrying a current of 25 to 50 periods and 6,000 to 12,000 volts.

The three overhead or trolley wires have an area of 100 square millimeters (0.155 square inch) and lie in a vertical plane 1.45 meters (4.76 feet) from the center line of the track; the lower one being 5.5 meters (18 feet) above the upper surface of the rails. The masts are 35 meters (115 feet) apart. At each kilometer (0.6214 mile) the wires are anchored, and at the half-way points there are stretching devices. Each wire has on it a tension of about 1,000 kilogrammes (2,204 pounds average). At each kilometer there is a lightning-arrester and the usual "horn" lightning-protector on the mast. On the bracket arm of each mast there is a device to cut out the current in case a wire breaks (the broken wire is put in electric connection with the next rail). This line was tested up to 14,000 volts.

It is noteworthy that after stretching these lines and before connecting with the central station, they were found, on merely touching them, sensibly charged with electricity. The working current in this circuit occasioned disturbance in the apparatus of the neighboring low-voltage State railway.

The bows which led off the current had a pressure of 4 to 6 kilogrammes (8.8 to 13.2 pounds) against the line. At all speeds, and at all tensions up to 13,500 volts, there were no disturbances in the off-take of the current; there was but very little sparking at the bows, and this only on certain less carefully stretched sections.

The tests have shown that at speeds of 40 meters (131.2 feet) per second or 87.7 miles an hour, up to 700 and even 800 kilowatts of current could be taken off, even in bad weather; and in this particular leave no cause for anxiety or uncertainty for higher speeds.

The four motors of each car were proved to 300 horse power each before being put in place, and all the switches, etc., were carefully tested by a 600-kilowatt alternating-current machine, at 13,000 volts. The tests of the cars on rollers at speeds corresponding to 200 kilometers (124 miles) an hour are described in the SCIENTIFIC AMERICAN SUPPLEMENT, No. 1350, page 21639; the description need not be here repeated.

The cars were made so as to be usable on the State railways after removal of the trolley bows. The bodies rest on two "bogies" or swivel trucks and have stepped bolster-pin plates; there are also on the side frames of each truck four plates to limit the lateral vibration by taking part of the weight off the car. (Such lateral vibration disappeared at speeds of over 100 kilometers [62.14 miles]).

The six-wheeled trucks carried a motor on each outer axle. The wheel-base was 3.8 meters (12.5 feet), the distance between truck centers (two different cars) 13.3 and 14.3 meters (52.5 and 55.8 feet); the practical diameter of each wheel 1.25 meters (4.1 feet or 49 inches). Over each axle-box was a leaf spring 1.5 meters (59 inches) long, these again coming on spiral springs, the tension of which was regulated by screws. The cars were 21 and 22 meters (69 and 72 feet) long. The weight on each axle, when unloaded, 7.5 to 7.6 tons. (Reduction in this weight now seems to the designers possible).

The cars ran more quietly at 120 to 130 kilometers (74.6 to 80.8 miles) than the usual trains at 90 kilometers (55.9 miles). At higher speeds, however, there was lateral slinging, shown by a pointer in the floor to amount to 5 to 10 millimeters (0.2 to 0.4 inch) each way from the axial line.

In the A. E. G. car the high-tension current is carried by a cable from the two groups of trolley bows to the main switchboard in the motorman's room and thence to the transformers by separate conductors. The main cutout is used only at the end of the trip or in case of accident. From the transformers the low-tension conductors lead through the main switchboard to the motors. This main switchboard is in the machine room and can be controlled from each motorman's place by hand wheels and sprocket chains. The switches control the admission of the current to the motors and resistances, and the reversing appliances as well as the shifting for braking by counter current. Further, a small switch at the motorman's place controls a low-tension current from the transformer for driving the compressor for the air-brake.

In the Siemens-Halske car the high-tension current arrives at two main switchboards, for forward and backward running, respectively, controlled from the motorman's stand; thence to the two main transformers From these latter the low-pressure current passes through a separate switch for each motor and resistance. From the main conductor on the car roof part of the current is taken off to small transformers above the motorman's stand, and thence to the air compressors. For the reversing appliance and the motor switches there are at each motorman's stand two special cranks, and the resistances are controlled by him by means of a special wheel, either with or without the aid of compressed air.

Both systems have worked well.

The transformers in the A. E. G. car have only three parallel iron cores, the axes of which are parallel to that of the car. Each core has a longitudinal slot through which, as well as through the square cores and the round coil, there can be driven an air current taken from "catchers" on the roof.

In the transformers in car S the effective layers of iron are arranged vertically and divided into sections, between which there are air spaces. The secondary winding is insulated from the iron core, and above it lie the primary coils. In the cooling spaces of the iron core there are protective cases, which reach to the end plates of the framing and are there widened out into air-catchers.

The transformers in both cars have done well, and kept cool. In the Siemens car the temperature after 230 kilometers (143 miles) made in 14 trips at a speed of 120 kilometers (74.6 miles) was only 35 deg. C. or 95 deg. F.

In the six-pole motors for the Siemens car of 250 horse power each, the "energy current" of 1,150 volts is delivered to the inner rotating part through three contact rings. The tension in the secondary circuit is, at rest and at starting, 650 volts. The rotating part has a closed "staff-winding" for continuous current; the stationary part is staff-wound for alternating current. The rotating part is 780 millimeters (30.7 inches); the entire motor 1,050 millimeters (41.3 inches) in diameter.

The motors for the Siemens car are also of 250

horse power each and have "forked staff" winding. The exciting current has 435 volts tension.

The tests showed that alternating current motors are perfectly suitable for standard-gage roads and high speeds.

A notable difference in the electrical arrangements of the two cars is in the "cut in" and resistance apparatus for regulating the speed. To prevent sudden jumps and sparking the switching in must be gradually effected. The A. E. G. car has liquid resistances. In the central machine compartment there are two vessels in which the electrodes dip. Near each there is an electrically-driven centrifugal pump, by which the level of the liquid, and thereby the resistance, can be altered. In the bottom of the vessel is a valve by which the motorman can empty the vessel. When this valve is closed the vessel is filled to overflowing and gives a constant minimum resistance, which determines the motor speed. The pumps work constantly when the car is in motion, thus keeping the liquid cool.

In the Siemens car there are ribbon resistances of "Kruppin" alloy, 45 x 2 millimeters (1.7 x 0.08 inches) in cross section, set in groups in flat boxes outside the car, under the windows. There are 29 stages; four for starting and 25 for regulation. Below the boxes lie the resistance cylinders, on which there are spiral sliding-contact strips of bronze. The outer contact-pieces are insulated and attached to two parallel steel tubes and are switched in one after the other. The rollers are rotated by a bevel wheel driven by a shaft from the motorman's stand. There is for this arrangement a compressed air drive that automatically comes back to the zero point when the current is cut off.

The two motor cars had run in all but up to the date of the report made by Geheimer Baurat Lochner, 3,000 kilometers (1,864 miles) during the fourth set of tests, at tensions of 10,000 to 13,500 volts.

As the earliest brake tests were unsatisfactory, even in "emergency" stops, the original pressure-valve was replaced by the one used on the Prussian State railways.

There was trouble from hot brake shoes and tires, with stops, at high speeds; the tires getting blue; so hollow shoes, with water circulation, were tried. This gave some relief, but not enough, and it is proposed to brake on the axles or the rails.

The friction coefficients of these tests are lower than those given by Galton and Westinghouse in 1878-79 and Wichert in 1887-78; probably on account of indifferent adjustment of the brake rods and consequent unequal pressure on the shoes. The material of tires and shoes may also make a difference.

With hand-braking at 100 kilometers (62.14 miles) the cars were stopped within 720 meters (2,362 feet) in 42 seconds, an average showing of 0.66 meter (2.13 feet) per second.

With the A. E. G. car tests with counter-current braking were made, but with little success, although the result was better at high than at low speeds.

In any case, this is only regarded as emergency practice, as there is danger of injuring the motors thereby.

The "runaway" tests correspond to final speeds of 109 and 106 kilometers (67.7 and 65.9 miles) per hour on the out and on the home trip respectively on the same reach. On one test the distance run after cutting off the current was 9,600 meters (5.97 miles); on the other 8,300 meters (5.16 miles); the times being 817 and 952 seconds respectively. The wind was WNW, and its velocity 11.4 meters per second, or 25.4 miles an hour, offering most resistance on the trip toward Zossen. These tests show an average retardation by wind of 0.034 meter (0.116 feet) per second, or nearly 0.8 miles per hour. This resistance was about 3.6 kilogrammes (7.94 pounds average) per ton of train instead of the usually-accepted 5.4 kilogrammes (11.9 pounds average), but in any case we may consider that the resistance is due to car surface and not to be reckoned in units of weight.

In starting, with increase of speed of from 0.1 to 0.2 meter per second (0.23 to 0.45 mile per hour) the power consumed varied from 400 kilowatts (544 horse power) to 740 kilowatts (1,000 horse power); in long runs, from 184 kilowatts (245 horse power) at 90 kilometers (56 miles) to 520 kilowatts (707 horse power) at 140 kilometers (87 miles) the power consumption increases more rapidly than the speed; and at 200 kilometers (124 miles) would probably be about 814 kilowatts, or 1,100 horse power.

While alternating currents are not as easily measured, there is sufficient correspondence between the various data to enable us to put confidence therein.

A study of the graphic representation of the power required shows a great reduction of tension in the three 13 kilometers (8.1 miles) of copper feeder wires of 50 square millimeters cross section. The loss here is greater than in the trolley circuit and would be, even in case the current had been taken from the Zossen end.

The tests show that between 115 and 118 kilometers (71.5 and 73.2 miles) per hour the mean power consumption at the trolley bows or loops was 400 to 450 horse power, and at the feeding point 430 to 480 horse power, while that at the wheels was 375 to 400 horse power. This shows an electrical duty of the car of 90 per cent and of the car and circuit together 85 per cent. The power at the engine crank would be, if the power station were at the feeding point, and the dynamos had 95 per cent duty, 479 horse. The combined duty, therefore, was 80 per cent.

Higher tensions would lessen the losses in current. The cost of the electric drive for the speeds attained cannot be accurately given, because the motors were planned and built for higher speeds.

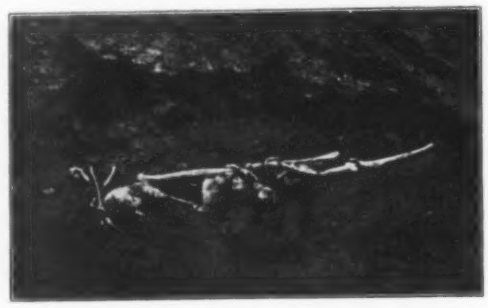
The experiments, as regards the resistance of the air, seem to me to be unreliable, by reason of the unsatisfactory methods for measuring. The form, direction and position of the openings in which the air currents were taken, affect the readings. It may be said that the pressure in kilogrammes per square meter of surface at right angles to the car axis was 0.065 the square of the velocity in meters per second. That is, for a car-speed of 27.78 meters per second (100 kilometers, or 62.41 miles per hour), the air pressure per square meter would be $0.065 \times 27.78 \times 27.78 = 50.2$ kilogrammes, while at 41.67 meters per second = 150 kilometers, or 93.6 miles an hour, it would be $0.065 \times 41.67 \times 41.67 = 113$ kilogrammes.

In pounds per square foot for these speeds these would be 10.26 and 23.1 respectively.

As regards the precautions for safety, between Mahlow and Rangsdorf only the straight reaches were run and the switches on these were specially locked. To prevent overrunning the sections there were special signal boards which could be placed at points determined according to the weather. Level crossings were specially guarded, and kept closed all the time that the electric cars were on the section, until they had passed. The visual signals used by the military railway for measuring speeds of 80 kilometers (49.7 miles) were not plain enough for 120 kilometers, even in clear weather; and when it rained the drops on the window prevented their being seen further than 200 or at most 300 meters, say 656 or 984 feet. But at 160 kilometers the signal to brake must be seen at least 1.5 to 2 kilometers (0.93 to 1.24 miles). Further, the visual signals must be supplemented at high speeds by acoustic, operated by electricity.

The final experiments made after the report of Geheimer Baurat Lochner were principally repetitions, at slow speeds, of the previous tests; the condition of the permanent way not permitting any more high speed tests. Robert Grimshaw.

Hanover, Germany.



AN EXCAVATED SKELETON.

EXCAVATION OF THE ADENA MOUND.

By William C. Mills, B.Sc., Curator of Ohio State Archæological and Historical Society.

The Adena Mound, so named by Gov. Worthington, and owned by his estate until a few years ago, was thoroughly examined by the Ohio State Archæological and Historical Society under the direction of its Curator during the summer of 1901. The mound is located one and a half miles from the northwestern part of the city of Chillicothe, in the valley of the Scioto River. In 1798, when Governor Worthington came to Ohio, he purchased the land upon which this mound was located, and it has since been owned by the heirs until a few years ago, when it was sold to Mr. Joseph Froehlich. Consequently the mound has been preserved for more than a hundred years. Mr. Froehlich, however, found that it was quite an expense to keep it in good condition, and decided upon its removal.

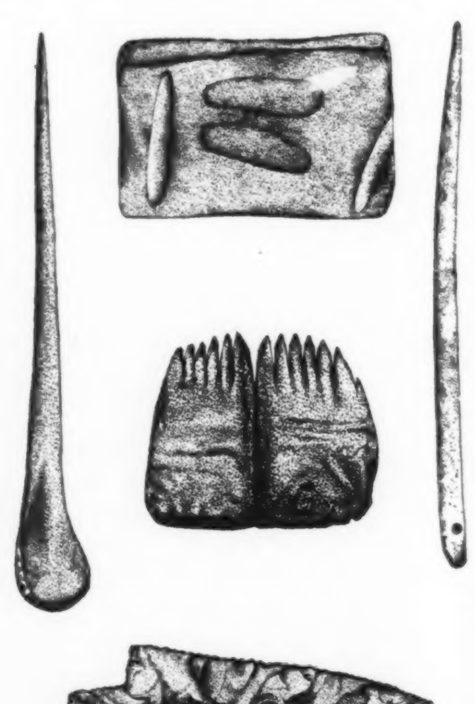
EFFIGY PIPE.

At the time this work began, the mound was 26 feet high, with a circumference of 445 feet. As work progressed it was discovered that it had been built at two different periods, the first period representing the original mound, which was 20 feet high with a base diameter of 90 feet, being composed almost entirely of dark sand taken, no doubt, from the small lake nearby known as Lake Ellensmere. The second period shows the enlargement of the original mound on all sides. On the south side it was covered with only a few feet of soil, while on the north side the base was extended more than 50 feet. This enlargement was carried up the side of the mound, changing the apex between 12 and 15 feet. The soil of the second period differed very much from that of the first. The first was composed almost entirely of sand and was of a dark color, while the second part was composed of a sand of a lighter color, mixed with the soil of the surrounding surface. The mode of burial in the first period was far different from that of the second. In the outer mound skeletons were found from the top to almost the bottom, while in the original mound no skeletons were found above 5 feet from the base line. The bodies in the first period were enveloped in bark or a coarse woven fabric and then inclosed in a rude sepulcher made of timbers. The sepulchers varied greatly in size, being made by placing large logs on each side of the body with a covering of small logs laid on the top. The timber framework had long since decayed away, but the cast of it was still retained in hard sand. This inclosure of timber, measured from outside to outside, was usually 8 to 9 feet in length, from 5 to 7 feet wide, and from 18 inches to 2½ feet high. As the covering of small logs decayed the superincumbent earth would drop into the grave. With the sides and ends supported, and no support in the center, this would naturally form an archway of earth, which was clearly defined at the time the mound was opened. In a number of instances the loose earth was removed from the sepulchers, disclosing large rooms, some of which were 10 feet long and 7 feet wide, with arched roofs.

The implements and ornaments found in both sections of the mound were similar in every respect, though more abundant in the first period than in the second. A total of thirty-three skeletons were removed, twenty-one occurring in the first period, or the original mound, and twelve in the second period.

The mound was removed in five-foot sections, commencing at the top. The first skeleton discovered, about nine feet from the top, was that of an adult, the right arm of which was encircled by two copper bracelets. These bracelets were made from a rounded piece of copper tapering to almost a point at each end, the ends overlapping each other where bent around the wrist. Wrapped around the bracelet was a quantity of well-preserved woven cloth, which showed the texture very nicely. Two copper rings were discovered on a finger of the left hand, also made of hammered copper and formed into a light wire, which was coiled twice around the finger. Other skeletons were soon unearthed bedecked with similar ornaments, one skeleton having upon the head a headdress made of large strips of mica cut into shape and pierced with holes for attachment. A number of shell hoes made of the fresh-water mussel were scattered through the central portion of the mound. These shells were made by cutting a hole through the shell for attachment.

When the last cut was begun, following the base line, it was soon discovered that this line gradually dropped toward the center, showing that the earth had been removed to form a hollow basin, in the center of which was dug a large grave 13 feet 9 inches long, 11 feet 4 inches wide and 6 feet 9 inches deep. The first two skeletons found in this cut were laid parallel, but in reversed positions. Both were covered with bark, but no traces of cloth were discernible. On the right



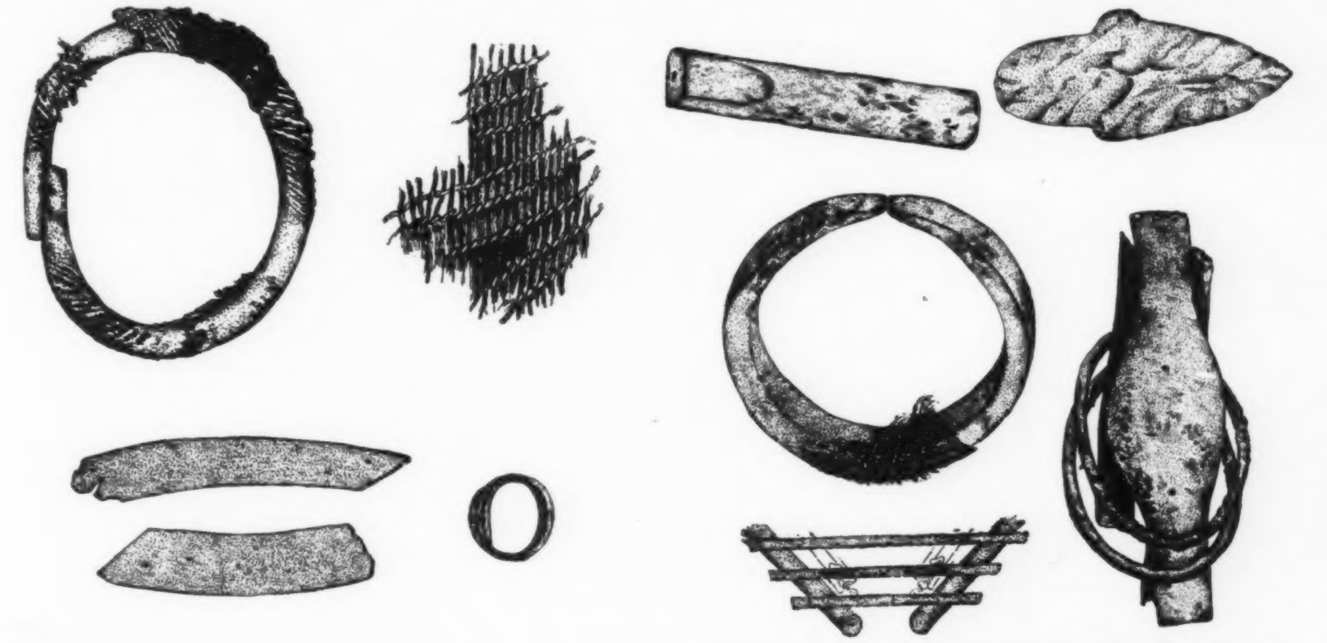
SANDSTONE TABLET, ELK-BONE COMBS, AWL AND NEEDLE, AND SPEARHEAD.

wrist of the first skeleton was a slate gorget and directly between the two skeletons was a tube pipe made of clay, presumably fireclay. The pipe was 4 inches in length and ¾ inches in diameter, with a bore ½ inch in diameter, tapering to a point where it is only ¼ of an inch. One skeleton found had evidently been previously buried in some other place and later transferred to this mound, as the skull was placed in the center of the grave with the foramen magnum turned upward, and surrounding it were bones of the leg, arm

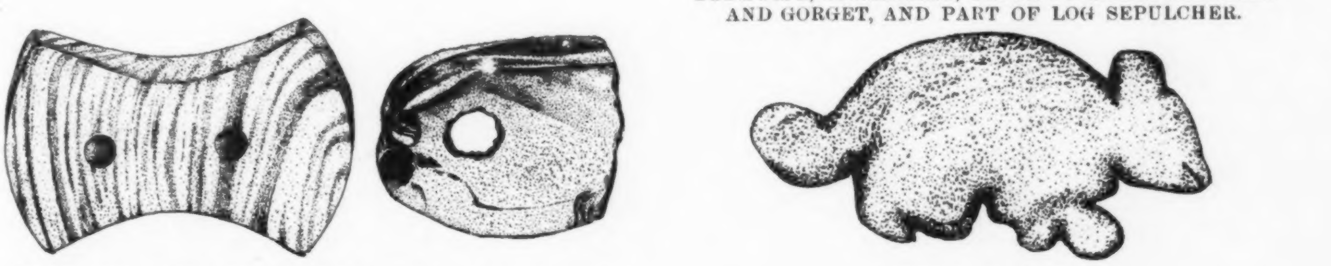
and vertebræ. At one end were the cervical vertebræ and the bones of th hand and foot. At the other end were the bones of the ribs, arms and lower legs. Throughout the mass upward of 200 beads made of bone and shell were found. On the right arm of another skeleton were two copper bracelets which encircled a boat-shaped ornament pierced with two holes. Through these holes were strings that had been preserved by the action of the copper, the string showing that the gorget had been attached either to the arm or to a woven fabric that was found associated with the bracelets. This boat-shaped gorget was 5¾ inches in length and made of limestone.

The bottom of the large center grave, mentioned above, was covered with a layer of bark which extended up the sides and over the surrounding surface for ten feet on all sides. In this grave was a skeleton which had been wrapped in three distinct layers of bark and was in a fair state of preservation. The skull was badly crushed and both of the arms broken. The tibia and fibula of both legs were painted red; evidently the flesh had been removed from the bones, the paint then placed on them, and the whole covered with a plaster made of mud. Around the feet and loins was found a remnant of a woven fabric similar to the fabrics already described. Near the feet were nine large leaf-shaped knives made of flint obtained from Flint Ridge. These were finely wrought and ranged in length from 3 to 4 inches. Here was also found a tablet made of fine grained sandstone, 4 inches long by 2½ inches wide and ½ inch thick, with long indentations on one surface. It was no doubt used in the manufacture of bone implements and ornaments. Among other articles of interest placed in this grave were two pieces of rib bones, presumably those of the elk, cut in the shape of combs. The combs had evidently been fastened together, as they were found in the position illustrated. Here also were a number of large awls from 6 to 11 inches in length, all made of the shoulder blade of the elk, and a needle 7¼ inches long, the point being very sharp and round but gradually tapering and flattening toward the other end, which was pierced by a small hole ⅛ of an inch in diameter.

Skeleton No. 21, placed on the north side of the mound, was perhaps the richest find. It was placed in a sepulcher made of very large logs; the one on the outside measured 17 inches in diameter and 16 feet in length; the log which formed the inside of the sepulcher was 12¾ inches in diameter and 19 feet in length. The logs were placed 8 feet apart, and the top covered over with small logs varying in diameter from 3 to 7 inches. In this sepulcher beads were found in great numbers composed of shell, bone and fresh-water pearls. The pearl and bone beads were placed about the neck in three strings, while the shell beads seemed to have been attached to a coarse cloth which evidently surrounded the loins. One ornament made of shell was no doubt meant to represent a raccoon. The most interesting find was that of an effigy pipe, 8 inches in length and composed of clay resembling the fire-clay found in Scioto county, which is further south, but in the same valley. The pipe is tubular in form, the hole extending the entire length of the body. The large opening is between the feet, having a bore ⅝ of an inch in diameter. Within an inch of the top of the head, it begins to narrow down to a very small aperture ⅛ of an inch in diameter. The mouthpiece forms a part of the headdress of the image. The front part of the pipe is a light gray color, while the back part is a brick-red. The specimen is covered with a deposit of iron ore which appears in small blotches over the entire surface, one side of the face and body being more densely covered with it than the other parts of the pipe. The effigy represents the human form in a nude state with the exception of a covering, which extends around the body and is tied at the back, the ends hanging down and serving as ornaments. A serpentine or scroll-like ornamentation is formed on the covering at the front. From the lobe of each ear is hung an ear ring quite large in proportion to the ear, and resembling the button-shaped copper ornaments so frequently found in the mounds of Scioto Valley. However, none of these ornaments were discovered in this mound, though quite a number have been found in the immediate neighborhood.



TUBE-PIPE, SPEARHEAD, CLOTH-COVERED BRACELET AND GORGET, AND PART OF LOG SEPULCHER.



BRACELET, CLOTH, HEAD DRESS, HOES, AND GORGET. EFFIGY OF RACOON.

RECENT DISCOVERIES IN CHINESE TURKESTAN.

DURING the last twelve years or so, the attention of scholars has been repeatedly arrested by remarkable discoveries of ancient Hindu manuscripts in Central Asia. In 1889, Lieutenant Bower found an ancient birch-bark manuscript in Kuchar, in the northern portion of Chinese Turkestan. This "Bower Manuscript" was at once recognized as the oldest Indian manuscript extant. In 1891 and 1892, M. Petrovsky, Imperial Consul-General of Russia at Kashgar, and the Rev. F. Weber, missionary in Leh, Ladakh, made no less important finds of old manuscripts in the region of Kashgar. Again, in 1897, the French traveler M. Dutreuil de Rhins found, in the vicinity of Khotan, some leaves of a very ancient birch-bark manuscript, in which M. Senart recognized fragments of a Prakrit version of the well-known Buddhist text, the Dhammapada. Meanwhile Dr. Hoernle, then principal of the Calcutta Madrasah, to whom we are indebted for a splendid edition of the "Bower Manuscript," had drawn the attention of the government of India to the remarkable records of ancient Hindu civilization to be found in Central Asia, and on his recommendation instructions were issued to the British officials in Kashgar and Ladakh concerning the acquisition of antiquities from Chinese Turkestan, and a "British Collection of Central-Asian Antiquities" was gradually formed at Calcutta.

But all these had been more or less casual discoveries, and as soon as it became known that European officials were ready to pay high prices for such antiquities, native "treasure-seekers" made it their business to ransack the ancient sites in the desert, not without damaging them, for manuscripts and other remains, and some of them were even unscrupulous enough to manufacture "old books" and sell them to Europeans as "antiques" unearthed in the desert. In these circumstances it became really a matter of urgency that systematic explorations, by some competent scholar, should at once be undertaken in these parts, all the more so as no part of Chinese Turkestan had ever been explored from an archæological point of view. No man could have been better fitted for this task than Dr. M. A. Stein, who, by his excellent topographical and archæological work in Kashmir and other parts of India, as well as by his scholarly edition and translation of the "Chronicles of the Kings of Kashmir," has shown that he combines the thoroughness and profound knowledge of the true scholar with the energy and hardiness, the practical experience and tact of the explorer. All students of India must feel thankful to the Indian government for securing the services of such a man for the archæological and topographical exploration of Chinese Turkestan.

In June, 1900, Dr. Stein was placed by the government of India on a year's special duty, for the purpose of exploring the southern portion of Chinese Turkestan and more especially the region of Khotan. A Chinese passport from the Tsung-li-Yâmen was obtained, authorizing him to travel and make excavations in Chinese territory. The Survey of India Department rendered material assistance by deputing one of the sub-surveyors, Babu Ram Singh, to accompany Dr. Stein on his travels, and by providing the necessary equipment of surveying instruments. Thus Dr. Stein was enabled, throughout the whole of his journey, to carry on geographical work along with his most interesting archæological researches.

A "Preliminary Report,"* published by Dr. Stein shortly after the completion of his journey, gives information about the character and scope of his explorations and their principal results. As to the intrinsic historical value of the discoveries made there can be only one opinion. It is true their full import will only be realized after the publication of the detailed report to be expected from Dr. Stein himself, and after a thorough examination of the archæological specimens, photographs, coins and manuscripts which will occupy scholars for many years to come; but even a perusal of the "Preliminary Report," and a glance at the illustrations and plates added to it, suffice to show that they will shed a flood of light on the history of an important period, and on the manifold relations between India and Central Asia during the first centuries of our era.

Dr. Stein left Srinagar on May 29. He traveled by the Gilgit-Hunza route, and on June 28 crossed the Kilik Pass and entered Chinese territory on the Taghdumbash Pamir. A five days' journey down the valley of this Pamir brought him to Tashkurghan, the chief place of the Sarikol mountain tract. Marching down the plains of Kashgar, he arrived, on July 29, safely at the capital of Chinese Turkestan. In Kashgar he made the necessary preparations for his travels in the desert, not only by organizing a fresh caravan, but also by making efforts to secure the good-will of the Chinese authorities for the intended explorations. In these efforts he was assisted, not only by Mr. Macartney, the diplomatic agent of the government of India at Kashgar, but also by the famous Chinese pilgrim of the seventh century, Hiuen-Tsiang. "All educated Chinese officials," writes Dr. Stein, "seem to have read or heard legendary accounts of the famous Chinese pilgrim's visit to the Buddhist kingdoms of the 'Western countries.' In my intercourse with them I never appealed in vain to the memory of the 'great monk of the T'ang dynasty' (T'ang-Sên), whose footsteps I was now endeavoring to trace in Turkestan, as I had done before in more than one part of India."

On September 11, Dr. Stein left Kashgar and started on his journey to Khotan, choosing for his march to Yarkand, not the ordinary caravan route, but a track leading through the desert. After a short halt in

* "Preliminary Report on a Journey of Archæological and Topographical Exploration in Chinese Turkestan." By M. A. Stein, Indian Educational Service. Published under the authority of H. M.'s Secretary of State for India in Council. (London, 1901.)

Yarkand, he proceeded on the caravan route leading to Khotan along the southern edge of the desert, following "the same great thoroughfare by which in earlier times the trade from the Oxus region and the far West passed to Khotan and to China." A peculiar feature of this route and of the desert around Khotan are the "Tatis," as the natives call the "extensive patches of ground where the eroded loess is thickly strewn with fragments of coarse pottery, bricks, slag, and similar refuse marking the sites of villages and hamlets long ago abandoned"—an ideal marching ground for the archæological explorer. He reached Khotan town on October 12. The next four weeks were devoted to geographical work in the Kuen-luen range and Khotan mountains, whereupon he turned again to archæological interests, paying a visit to the Kohmari ridge opposite the village of Ujat, and examining old sites in the Khotan oasis, more especially those near the village of Yotkan, where "treasure-seeking" has long been carried on along with jade-digging and gold-washing. Having finished the survey of ancient localities within the oasis, he started on December 7 on his way to Dandan-Uiliq, the site chosen for the first excavations in the Taklamakan desert. Marching through the desert, the small caravan, including a party of thirty laborers for the excavation work, found itself on December 18 in the midst of the scattered ruins of Dandan-Uiliq. This ruined site had been seen by Dr. Sven Hedin on his march to the Keriya Darya, and is spoken of in the narrative of his travels as "the ancient city of Taklamakan." For fully three weeks most successful excavations were carried on by Dr. Stein among these ruins. On January 6, 1901, he left this neighborhood and marched across sand dunes, rising to a height of about 200 feet, to the Keriya Darya, and along the hard frozen river to the oasis and town of Keriya, in order to secure the assistance of the Amban (the Chinese district magistrate) for his further explorations. Making inquiries at Keriya about old localities, he heard of an "old town" in the desert north of the Muhammadan pilgrimage place of Imam Jafar Sadik. He set out in search of this ancient site, and reached Niya—the Ni-jang town of Hiuen-Tsiang—on January 21. Six days later he was among the ruins of the Niya River site, as Dr. Stein, in absence of any special local designation, calls this site, where the excavations, carried on for nearly three weeks, yielded the most important results of the whole journey. At Niya he had heard of old remains to be found in the desert to the east toward Cherchen, and he set out in search of them. Marching more than a hundred miles to the east from Imam Jafar Sadik, he reached the point where the Endere stream is lost in the sands. A day's march further to the southeast brought him to the "old town of Endere," which was next explored. Interesting archæological remains and manuscripts were brought to light by the excavations. Some Tibetan manuscripts found here showed that the easternmost point of the exploration area had been reached. Hence Dr. Stein began to march back to Keriya and Khotan. Some 150 miles north of Keriya the ruins of Karadong—as they are called by the nomadic shepherds grazing along the Keriya Darya—were visited and explored by Dr. Stein, before he continued his march to Khotan. The sand-storms and increasing heat warned him that work in the desert would soon become impossible. He hastened, therefore, to visit the ancient sites to the northeast of Khotan which had still to be explored. After examining the scanty ruins of Aksipil, some fifteen miles from the right bank of the Yurung-Kash opposite Khotan, he marched due north through the sands for about fourteen miles, when he reached the ancient site called Rawak by native "treasure-seekers." Here the last, but by no means the least interesting, excavations were carried on for a whole week. On April 18 the work was finished, and, having completed the programme of his explorations in the desert, Dr. Stein could return to the town of Khotan, where he arranged and carefully repacked his archæological finds. On May 1 he sent out for Kashgar, where he made arrangements for his journey to Europe. He left Kashgar on May 29, and traveling through Russian Turkestan he reached, at Andijan, the terminus of the Transcaspian Railway. By it he traveled to Krasnovodsk, crossed the Caspian to Baku, and finally, on July 2, arrived in London, where he was able to deposit his important collection—twelve large boxes, containing numerous relievos, frescoes, painted tablets, and other specimens of Central Asian art, coins, manuscripts, and more than 800 negatives on glass plates, the photographic results of his journey—in the British Museum. A three months' period of deputation in London had to suffice for the provisional arrangement and cataloging of his precious finds and for preparing the "Preliminary Report."

It would require far more space than I could be allowed in these columns to mention only the most important results of Dr. Stein's explorations. I must content myself with just pointing out the most striking features of the discoveries recorded in the "Preliminary Report." Though archæology and historical topography were the chief interests, and the desert around Khotan was the principal area of the explorations made by Dr. Stein, he missed no opportunity, throughout the whole of his journey, to attend to general geographical work as well and to make valuable anthropological and ethnographical observations.

Thus, in the interests of geography, he superintended the survey on the Taghdumbash Pamir and in the Sarikol mountain tract; and by choosing for his march to Kashgar the route which passes through the valleys between the Russian Pamirs and the western slopes of the Muztagh-Ata range, he was able to extend his survey to the Muztagh-Ata and the mountain ranges overlooking the Little Karakul Lake. Again, on his march from Kashgar to Yarkand he succeeded in fixing the position of Ordam Padshah more accurately than is done on the existing maps. After his arrival in Khotan he devoted a whole month to survey operations in the Kuen-luen mountain range, especially in that portion of it which contains the head-waters of the Yurung-Kash River. He also explored the hitherto unknown mountain tract toward the Karakash River and was able to complete the triangulation of the Khotan Mountains.

Anthropometric observations were made by Dr. Stein in all regions offering any anthropo-geographical interest, for instance among the Iranian hillmen in the Sarikol settlements. Nor did he omit to make notes of any popular legends and folk-lore connected with interesting localities, and often he found "old stories" which Hiuen-Tsiang had heard and recorded in the account of his travels, still alive among the population. The tenacity with which local legends survive proved often very useful in the identification of old sites. Thus, near the frontier of the Khotan district, there is a Muhammadan shrine known as Kaptar-Mazar, i. e., "the pigeon's shrine," at which thousands of pigeons are kept and propitiated by food offerings, and a legend is told of a great victory won with the help of pigeons by some Muhammadan hero over a host of Khotan unbelievers. Now Hiuen-Tsiang tells us that some thirty miles to the west of the capital of Khotan there was a range of hills supposed to have been formed by the burrowing of rats, the rats having been worshipped there owing to the popular belief that in ancient Buddhist times they had saved the land by destroying the leather of the harness and armor of some hostile army. The locality indicated by the Chinese pilgrim corresponds exactly to Kaptar-Mazar, and Dr. Stein has no doubts that the pigeons of the Muhammadan legend have taken the place of the rats of the legend as related by Hiuen-Tsiang.

During the whole of his journey, Dr. Stein paid the greatest attention to historical topography. Everywhere he tried to trace and identify ancient sites mentioned by Hiuen-Tsiang and other Chinese travelers. Thus—to mention only some of the more important results—Paloyo, the Dard designation of the people of Baltistan, was identified with the term Po-liu, as used in the Chinese annals and in the narratives of the Chinese pilgrims. Sir Henry Yule's identification of Sarikol with the K'ie-p'an-to territory of Hiuen-Tsiang was fully confirmed by Dr. Stein's investigations. On his march to Khotan he was able to identify the small oasis of Moji with the town of Po-Kia-i, where a famous Buddha statue brought from Kashmir was worshipped in the times of Hiuen-Tsiang. Following the road once used by the Chinese pilgrim, he traced other ancient sites near the oasis of Zanguya, and close to the frontier of the Khotan district. Two identifications, previously made by M. Grenard, were fully borne out by the evidence found by Dr. Stein—that of the Kohmari ridge and cave with the ancient Gosrnga mountain and the cave where the popular legend of Hiuen-Tsiang's time supposed a Buddhist saint to reside "plunged in ecstacy and awaiting the coming of Maitreya Buddha;" and that of the village of Yotkan with the ancient capital of Khotan. Among the many proofs for the latter identification, the most convincing was that, from this starting point, Dr. Stein was able to identify the positions of the most important Buddhist shrines visited by Hiuen-Tsiang, the places of which are generally occupied now by Muhammadan Ziarats. Thus, the small hamlet of Somiya was found to correspond exactly to the Buddhist convent described by the Chinese pilgrim under the name of Sa-mo-joh. Finally, we may mention that on his march from the Karadong ruins to Keriya, Dr. Stein identified the position of the town of Pi-mo, described by Hiuen-Tsiang, in the neighborhood of Lachim-Ata Mazar.

But it is chiefly for his archæological discoveries and his manuscript finds that Dr. Stein's journey of exploration will ever be memorable. We cannot enter here into details about the many interesting Buddhist monuments examined by Dr. Stein in the course of his travels in Gilgit, Hunza, Sarikol and Kashgar, and the antiquities collected by him on the Yarkand-Khotan route, in Khotan town and in the village of Yotkan. Also for the excavations made at the Endere site, at Karadong and at Ak-sipil we must refer the reader to Dr. Stein's "Preliminary Report." But a word or two must be said about the most important results of the excavations carried on among the ruins of Dandan-Uiliq, the Niya River site and of Rawak.

No less than fourteen detached temples and dwelling houses were excavated in Dandan-Uiliq. First of all two temple cellas were brought to light, richly decorated with wall paintings and stucco images. The interior of the larger cella was occupied by a colossal stucco statue, probably representing a Buddha. Each of the four corners of the same cella was occupied by a draped stucco figure standing on a lotus-shaped pedestal. The cella walls were decorated, inside with frescoes showing figures of Buddhas or Buddhist saints, and outside with fresco bands containing small representations of saints, seated in an attitude of meditation. In style of composition and the drawing of figures, these wall decorations are similar to the later of the Ajanta frescoes. But as we possess only very few specimens of old Indian painting, the study of the Dandan-Uiliq frescoes will prove of particular interest. For the same reason, the small painted tablets which Dr. Stein discovered on excavating the temple cellas are of importance. They were probably votive offerings from worshippers who had come to visit the shrines in ancient times. A figure represented on one of these tablets shows the head of a rat—which is interesting in view of the legend of sacred rats mentioned above. Near the excavated buildings Dr. Stein generally found groups of shrivelled and bleached trunks of poplar and fruit trees, the remains of ancient orchards or avenues. Also traces of old irrigation channels were recognizable in the sand.

Of the manuscripts excavated at Dandan-Uiliq, the most important are some oblong leaves of paper inscribed with old Indian Brahmi characters (i. e., the alphabet which is written from left to right, and used in the edicts of King Asoka, and similar epigraphic documents), and belonging to five different manuscripts, three of which are in Sanskrit and contain Buddhist texts. From their palæographic peculiarities Dr. Stein concludes that they cannot be later than the seventh, and may belong even to the sixth or fifth century. Moreover, there were found single leaves of thin, coarse paper, inscribed with cursive Indian characters, but showing a non-Indian language, and some Chinese documents of similar material and appearance. Two of the latter bear dates, according to which they must have been written between 763-805 A. D. Dr. Stein thinks that these dates indicate about the time when the dwellings were abandoned. The evidence of numerous coins found in the course of excavations supports this dating of the Dandan-Uiliq ruins.

Among the most interesting discoveries in the ruins at the Niya River site, there are remains of two large dwelling houses, excavated by Dr. Stein. In one of them some specimens of household furniture, illustrating the industrial arts of the period, were found, among others a wooden chair with ornamental wood carving, the decorative motives of which closely resemble those of the relievo sculptures of the Buddhist monasteries of Yusufzai and Swat (the ancient Gandhara). In one room, the stuccoed walls of which showed a carefully executed fresco decoration, the pieces of a colored rug—an interesting specimen of ancient textile industry—were brought to light. Again, in another of the excavated houses there were found the legs and arm-rests of a wooden chair, representing lions and human-headed monsters, and still retaining traces of color, and also the broken end of a kind of guitar, resembling the popular "Rahab" of modern Turkestan.

But most important of all are the manuscripts unearthed at the Niya River site. More than 500 wooden tablets inscribed with ancient Kharoshthi characters (i. e., the alphabet written from right to left, and known chiefly from Indo-Scythian and Indo-Greek coins, found in the northwest of India) were found among the ruins of this site. Most of them are wedge-shaped, from 7 to 15 inches long, and arranged in pairs; and some of them still retained their string and clay sealing intact, thus illustrating the ingenious manner adopted for the fastening and sealing of these documents. Other tablets were oblong, some of considerable length (up to 30 inches), resembling the Indian palm-leaf manuscripts. An ancient pen, made of tamarisk wood, with a bone knob, was found, and gives us some idea of clerical work in this remote period. A considerable number of these tablets were found in an ancient rubbish heap, and there were also some narrow pieces of wood inscribed with Chinese characters. The same rubbish heap yielded another very rare, and in a Buddhist country particularly surprising, writing material, namely, about two dozen documents written in Indian Kharoshthi characters on leather. A thorough examination of all these documents as to their contents will take much more time than Dr. Stein was able to bestow on them during his short deputation. But he could make out that most of them were written in an old Prakrit dialect with an admixture of Sanskrit terms, and the wedge-shaped tablets seem to contain correspondence, records of agreement, bonds, memoranda and the like, while religious texts, votive records, etc., will probably be found to form the contents of the longer tablets. As to the date of these documents, palæographical evidence proves them to belong to the first centuries of our era. For the writing resembles closely that on the inscriptions of the Indo-Scythian kings who ruled over the Punjab and the Kabul region during the first two centuries, and the Kharoshthi alphabet soon ceased to be used after that period. These wooden tablets must, therefore, be considered at present as the oldest Indian manuscripts extant. The use of wood as writing material is also a proof of considerable antiquity. From the fourth century onward the use of paper as writing material is attested for Turkestan. Yet not the smallest scrap of paper was discovered in the ruins of the Niya River site. Numismatic finds, as well as the influence of classical art shown on some of the clay seals attached to the tablets, confirm this dating.

The last excavations were those made at Rawak, where Dr. Stein found an imposing Stupa surrounded by a court forming a quadrangle 164 feet long and 143 feet broad. Both inside and outside, the walls of this Stupa court were decorated with rows of colossal statues in stucco, representing Buddhas or Bodhisattvas, and between them at frequent intervals with smaller relievos representing deities and saints. The whole of the relievo work had originally been colored, and there were fresco paintings besides. The excavations of these relievos proved no easy task, as the structures threatened to collapse when the sand was removed. Yet Dr. Stein succeeded in clearing ninety-one large and numerous small relievos. Photos were taken of the larger relievos, while the smaller ones were taken to England. In style and details of execution the Rawak sculptures resemble the Græco-Buddhist sculptures of the Peshawar Valley and the neighboring regions. Chinese copper coins, found among the ruins, proved to be coins of the Han dynasty. As the rule of the kings of this dynasty covers the period of 25-220 A. D., and some of their coins are known to have been current until the close of the fourth century, we have thus a chronological limit, to which the Rawak sculptures may safely be referred.

Finally, we must at least touch upon one negative, though none the less important, result of Dr. Stein's journey of exploration. During his last eight days' stay at Khotan he succeeded in clearing up the doubts he had long entertained concerning the genuineness of certain very puzzling manuscripts and blockprints "in unknown characters" which had for some years past been purchased from Khotan and added to the "British Collection of Central Asian Antiquities" in Calcutta. With the help of the Chinese authorities he got hold of the very man—one Islam Akhun—from whom most of these documents had been bought. The man was brought before Dr. Stein, who forced from him, in the course of a prolonged cross-examination, an open confession of his manufacture of "old books." Dr. Stein has shown that it is easy to distinguish the forgeries from genuine old manuscripts, and there is no fear that any scholar will, in future, be deceived into trying to decipher the "unknown characters" of Khotan manuscripts.

This brief sketch will suffice to give an idea of the singular importance of the discoveries made by Dr. Stein. But the costly treasures brought by him from Chinese Turkestan will require the most careful examination and study to be made fruitful for further

research, and who could be better fitted for this task than the happy discoverer himself? While congratulating both the Indian government and Dr. Stein on the brilliant discoveries made in Central Asia, we can only express our sincerest hope that the authorities of the India Office may see their way to grant Dr. Stein the leisure required for completing the work so happily begun, in order that the present "Preliminary Report" may soon be followed by a retailed report of Dr. Stein's tried workmanship.—M. Winternitz, in Nature.

SELECTED FORMULÆ.

1. COSMETIC JELLY FOR THE HANDS.

Tragacanth (white ribbon)	60 grains
Rose water	14 ounces

Macerate for two days and strain forcibly through coarse muslin or cheese-cloth. Add glycerin and alcohol, of each 1 ounce. Perfume to suit. Use immediately after bathing rubbing in well until dry.

2. CRÈME MARQUISE (COLD CREAM).

White wax	¼ ounce
Spermaceti	2½ ounces
Oil of sweet almonds	2½ ounces

Melt, remove from the fire, and add,

Rose water	1½ ounces

Beat until creamy, not until cold.

When the cream begins to thicken we add a few drops of oil of rose. Only the finest almond oil should be used, and one should be careful in his weighing of the wax and spermaceti. These precautions will insure an elegant product.

3. ORANGE FLOWER SKIN FOOD.

White wax	½ ounce
Spermaceti	½ ounce
Cocoanut oil	1 ounce
Lanolin	1 ounce
Oil of sweet almonds	2 ounces

Melt in a porcelain dish, remove from the fire, and add

Orange flower water	1 ounce
Tincture of benzoin	3 drops

Beat briskly until creamy.

This preparation is used in massage for removing wrinkles.

4. ASTRINGENT WASH.

Cucumber juice	1½ ounces
Tincture of benzoin	½ ounce
Cologne	1 ounce
Elder flower water	5 ounces

Put the tincture of benzoin in an eight-ounce bottle, add the other ingredients, previously mixed, and shake slightly. There will be some precipitation of benzoin in this mixture, but it will settle out, or it may be strained out through cheese-cloth.

This article is used to correct coarse pores, and to remedy an oily or flabby skin. Apply with sponge night and morning.

5. CUCUMBER JUICE.

Slice any convenient number of cucumbers, without peeling; place in porcelain kettle, and add just enough water to keep from burning. Cook until pulpy, and strain with force through muslin. This preparation may be preserved by the addition of boric or salicylic acid.

In all these preparations use the best obtainable material, put them up neatly, call the attention of your feminine customers to them, and they will sell.

6. COOBAN'S FOOT POWDER.

(Pulvis Talci Salicylicus, N. F.)

Salicylic acid	1½ drachms
Boric acid	5 drachms
French chalk	4 ounces

Have these substances all in fine powder and mix them well. Put the preparation in pasteboard talcum powder boxes so that it can be sifted into the shoes for perspiring or tired feet.

7. COOBAN'S READY LINIMENT.

Water of ammonia	1 drachm
Chloroform	1 drachm
Sulphuric ether	½ fl. ounce
Oil of cloves	2 drachms
Oil of sassafras	1 ounce
Oil of turpentine	½ ounce
Camphor gum	2 drachms
Alcohol	14 fl. ounces

Mix, put up in two-ounce green panels.

Label with directions, and place each bottle in a carton. Sell for 25 cents.

8. BLACKBERRY CORDIAL.

Fennel seed	1 ounce
Powdered cinnamon	1 ounce
Powdered cloves	1 ounce
Glycerole of pepsin	2 ounces
Powdered opium	¼ ounce
Fluid extract of cardamom co.	1 ounce
Fluid extract of catechu	2 ounces
Brandy	1 pint
Fluid extract of hydrastis	1 ounce
Simple sirup	20 ounces
Blackberry wine, enough to make	1 gallon

Macerate one week, filter and put up in two-ounce green panels.

9. BEEF, IRON AND WINE.

Extract of beef	512 grains
Detannated sherry wine*	26 ounces
Alcohol	4 ounces
Citrate of iron and ammonia	256 grains
Simple sirup	12 ounces
Tincture of orange	2 ounces
Tincture of cardamom co.	1 ounce
Citric acid	10 grains
Water, enough to make	4 pints

Let stand twenty-four hours, agitate frequently, and filter.

See that the orange is fresh.

* To the sherry wine, in order to detannate, add ½ ounce of hot sweet milk, shake, and filter.

10. FURNITURE POLISH.

Linseed oil	20 ounces
Spirit of turpentine	12 ounces
Solution of antimony chloride	1 ounce
Vinegar	8 ounces
Wood alcohol	3 ounces
Camphor	¼ ounce
Ammonium chloride	3 drachms

Dissolve the camphor in the spirits, and the ammonium chloride in the vinegar. Mix the other ingredients with this in the order given. Shake for some time to secure a smooth, creamy mixture.

Put up in six-ounce prescription bottles, with appropriate labels, and sell for 25 cents.

11. LIGHTNING RENOVATOR.

This removes stains from all kinds of woolen goods, brightens black cloth, renovates carpets, etc.

Stronger ammonia water	1 ounce
Tincture of green soap	3 ounces
Sodium carbonate	2 drachms
Sodium borate	2 drachms
Ether	1 ounce
Alcohol	1 ounce
Water, enough to make	2 pints

Dissolve the salts in a portion of the water, and add the ammonia water and tincture of soap; finally add the ether and alcohol mixed.

12. TOOTHACHE CURE.

Chloral hydrate	1 av. ounce
Camphor	1 av. ounce
Chloroform	1 fl. ounce
Ether	1 fl. ounce
Oil of cloves	2 fl. ounces
Oil of peppermint	2 fl. ounces
Alcohol, enough to make	16 fl. ounces

Put up in two-drachm square vials. Sell for 10 cents.

13. LIQUID TOOTH WASH.

White Castile soap	1 ounce
Cologne spirits	6 ounces
Water	6 ounces
Glycerin	2 ounces
Oil of peppermint	20 minims
Oil of cloves	10 minims
Oil of cinnamon	20 minims
Oil of wintergreen	30 minims
Extract of vanilla	½ ounce

Dissolve the soap in the water by the aid of heat if necessary, and add glycerin and extract of vanilla. Dissolve the oils in cologne spirits and add to the solution first formed. Then filter and color red.

Be sure the oils are fresh, and do not put in more than the quantities specified—use less if anything.

14. CORN SALVE.

Salicylic acid	2 ounces
Ammonium chloride	2 ounces
Acetic acid	½ ounce
Lanolin	2 ounces
White wax	2 ounces
Lard, enough to make	1 pound

Mix the acid with the ammonium muriate, add the lanolin, and, lastly, the lard and wax previously melted. Mix thoroughly and pour into ¼-ounce tin boxes and allow to cool.

15. WORM SIRUP.

Fluid extract of spigelia	40 fl. ounces
Fluid extract of senna	24 fl. ounces
Oil of anise	80 drops
Oil of caraway	80 drops
Simple sirup	64 ounces

Mix and strain if necessary.

16. CARBOLIC SALVE.

Petrolatum	16 ounces
Paraffin	1½ ounces
Camphor	1 ounce
Carbolic acid	210 grains
Oil of sassafras	30 minims

Rub the carbolic acid, camphor and oil together until solution is effected. Add to the petrolatum and paraffin previously melted, and stir until cold.

This makes an excellent salve for general use.—Bulletin of Pharmacy.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Decortication of Ramie in France.—Walter T. Griffin, commercial agent at Limoges, informs the Department, June 20, 1902, that Mr. Pierre Faure, a well-known engineer of that city, has invented a machine for decorticating ramie. The new process, says Mr. Griffin, is rapid, practically automatic, and entirely satisfactory. The decortication is thorough, and does not injure the fiber. The machine is transported without trouble, and no more power is required to operate it than to operate an ordinary thresher. A field of ramie has been planted near Limoges, and in the latter part of July next the stalks will be harvested and decorticated by the new method.

The Chinese Language.—While China is considered the land of promise for our manufacturers and farmers, the importance of the knowledge of the Chinese language is greatly undervalued. I submit the details of a recent interview with a linguist who has given special attention to this subject.

It is well understood that in order to enter into permanent commercial relations with a foreign country it is indispensable to know its language. When Russian industries began to develop, the Germans recognized that in order to engage in profitable trade in that country it was necessary to learn Russian, and there is now no country where the Russian language is so much taught as in Germany.

The Chinese language is idiographic. It conveys the idea and not the word for a thing, as the figure "8" represents the idea and not the word. The Chinese have invented more than 40,000 marks for their writing. In the opinion of my informant, it will require only about 3,000 marks for mercantile correspondence, and it will be easier to learn them than the words of an ordinary foreign language.

Russian is more difficult for Americans than Chinese. It takes much longer to learn the spoken language, because of the variety of dialects; but anyone can learn enough of the writings to answer ordinary purposes in a few months and have his knowledge perfected by a linguist within about a year. An exact instruction in one of the Chinese languages can only be given by a Chinaman.

This method has been adopted in Germany. Besides the professor for the theory of language, there are four Chinese linguists in the Oriental Seminary of Berlin teaching the business style and the languages of Pekin, Shanghai, and Canton. It is not intended to fit pupils for the diplomatic service, but for commercial work.—Charles Neuer, Consular Agent at Gera.

The Tobacco Traffic in Austria.—The tobacco traffic is a government monopoly in Austria. All the cigars, cigarettes, etc., are either made in government factories or are imported by the government. The sale is conducted through licensed agents, whose number is limited and whose location is prescribed so that competition shall not prevent a lucrative business. The traffic is supervised by an official whose jurisdiction covers a specific territory subdivided among a number of assistants. The tobacco product is bought by the licensed dealers from these officials, and must be sold to the consumer at prices fixed by law, which yield to the seller about 10 per cent profit from the cheapest and 5 per cent from the dearest cigars. Hotels and restaurants, which seldom possess a license, must purchase tobacco of the licensed dealers and pay the same price as individuals. They can fix their own selling price, however, which they do by adding 1 kreutzer (0.4 cent) to the legal price of a cigar or cigarette.

The cheapest domestic cigar costs 0.6 cent; the dearest, 3.6 cents. The price for a thousand or a million is at the same rate. Each of the different kinds of cigars has a distinctive name, and as it never varies in flavor or quality, the purchaser always knows exactly what he will get for his money.

The tobacco for the domestic product is grown in the southern provinces of Austria-Hungary, in Egypt, and in Turkey, though the better grade of domestic cigars is made partly of Cuban tobacco.

From the official statistics of the Austrian tobacco industry for 1901, just published, it appears that the gross value of the product sold was 213,989,863 crowns ($43,439,942)—an increase of 3,000,000 crowns ($609,000), or 1.4 per cent over 1900. The average yearly increase for the preceding decade was over 5,000,000 crowns ($1,015,000); therefore, last year's traffic showed a relative decrease, owing, it is presumed, to the general business depression. The decline was specially apparent in this kingdom—Bohemia—where the increase fell from the average of 3.4 per cent to one-half of 1 per cent. The sale of cigars in Austria positively decreased 1.5 per cent in number and 1.8 per cent in value in 1901, as compared with 1900, while cigarettes—being cheaper—showed the marked increase of 6.8 per cent in number and 7.5 per cent in value.—Frank W. Mahin, Consul at Reichenberg.

Dynamite in South Africa.—Consular Agent Gordon telegraphs from Johannesburg, July 26, 1902, that a majority of the Chamber of Mines there favors the imposition of a coast duty of $1.80 per case on dynamite, to protect local factories. A strong minority desires free trade. The annual consumption is 300,000 cases. Mr. Gordon thinks United States factories should compete for this trade, and requests cable quotations from manufacturers for blasting gelatin and No. 1 dynamite, 30,000 cases yearly, five-year contract, delivered at an African port. These figures, he adds, apply to one group of mines only.

Automobile and Bicycle Exposition at Leipzig.—Consul B. H. Warner reports from Leipzig, July 7, 1902:

The Fifth Annual International Automobile and Bicycle Exposition will be held under the auspices of the Society of German Bicycle Manufacturers at the Crystal Palace, Leipzig, from the 18th to the 27th of October next. This year the exhibition will not be confined solely to automobiles and bicycles, but sewing machines, typewriters, cash registers, etc., will also be displayed. I am informed that there is already a great demand for floor space at the exposition, detailed information in regard to which can be obtained by writing to Herrn A. v. Slawinski, General-Secretair, Internationaler Markt & Ausstellung von Motarfahrzeugen, etc., Krystall Palast, Leipzig, Germany.

Demand for Catalogues in Amsterdam.—Consul Frank D. Hill, of Amsterdam, under date of July 24, 1902, writes that it would be advisable for exporters of iron, steel, coal and electrical supplies to send catalogues to that consulate, as he intends to devote a room exclusively to circulars of American firms, folders of American railways, steamship lines, cable companies, etc. He has received many visits of late from people interested in the import trade, and they desire data in regard to United States industries. Reports of chambers of commerce would also be useful.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

Coloring of Plaster.—If burnt gypsum is stirred up with water containing formaldehyde and with a little alkali, and the quantity of water necessary for the induration of the plaster containing in solution a reducible metallic salt is added thereto, a plaster mass of perfectly uniform coloring is obtained. The hardening of the plaster is not affected thereby. According to the concentration of the metallic salt solutions and the choice of the salts the most varying shades of color, as black, red, brown, violet, pearl-gray and bronze may be produced. The color effect may be enhanced by the addition of certain colors. For the production of a gray-colored gypsum mass, for example, the mode of procedure is as follows: Stir 50 grammes of plaster with ¼ its weight of water, containing a few drops of formaldehyde and a little soda lye and add ten drops of a 1-10 normal silver solution, which has previously been mixed with the amount of water necessary for hardening the gypsum. The mass will immediately upon mixing assume a pearl-gray shade, uniform throughout. In order to produce red or copper-like, black or bronze-like shades, gold salts, copper salts or silver salts, bismuth salts or lead salts, singly or mixed are used. Naturally, these colorings admit of a large number of modifications. In lieu of formaldehyde other reducing agents may be employed, such as solutions of sulphurous acid or hydrogen peroxide with a little alkali. Metals in the elementary state may likewise be made use of, e. g., iron, which, stirred with a little copper solution and plaster, produces a brown mass excelling in special hardness, etc. This process of coloring plaster is distinguished from the former methods in that the coloration is caused by metals in the nascent state and that a very fine division is obtained. The advantage of the dyeing method consists in that colorings can be produced with slight quantities of a salt; besides, the fine contours of the figures are in no way affected by this manner of coloring and another notable advantage lies in the mass being colored throughout, whereby a great durability of the color against outside actions is assured. Thus a peeling off of the color or other way of becoming detached, such as by rubbing off, is entirely excluded.—Farben Zeitung.

Scent Tablets.—Scent tablets consist of a compressed mixture of rice starch, magnesium carbonate and powdered orris root, saturated with heliotrope, violet or lilac perfume. The following perfumes are well adapted for this purpose:

VIOLET.

Ionon	50 grammes
Ylang-ylang oil	50 grammes
Tincture of musk, extra strong	200 grammes
Tincture of benzoin	200 grammes

HELIOTROPE.

Heliotropin	200 grammes
Vanillin	50 grammes
Tincture of musk	100 grammes
Tincture of benzoin	200 grammes

LILAC.

Terpineol	200 grammes
Muguet (Fritzsche & Co)	200 grammes
Tincture of musk	200 grammes
Tincture of benzoin	200 grammes

The above quantities are sufficient for 10-15 kilos of the said stock mass.—Pharmaceutische Zeitung.

Imitation of Schweinfurt Green.—

I. Auramin	0.5	0.5
Brilliant green	0.5	—
Malachite green	—	0.5
Heavy spar	70	70
Potato starch	30	30

Levigate the starch and heavy spar and enter in the vat through a sieve. Dissolve the auramin in hot water at 70 deg. C. and allow to cool. Brilliant green and malachite green should be dissolved boiling and cooled off. The dyestuff solutions should then be added to the starch-spar mixture with good stirring. Allow to deposit and filter off the precipitated dyestuff.

II. Permanent white	50
Flavine	3
Soda in crystals	1.5
Alum	2
Brilliant green	0.1

Levigate the permanent white, then add the solution of flavine and soda in 400 liters of water, next the alum solution and finally the solution of brilliant green in 50 liters of water. The precipitated lake is filtered.—Oesterreichische Farben- und Lack-Zeitung.

Exceedingly Durable Twine is said to be obtained by dissolving plenty of alum in water and laying the twine in this solution. After drying, the twine will be almost infrangible.—Der Seifenfabrikant.

Syndeticon.—The Drogen Zeitung cites the following useful recipes: I. Slack 100 parts of burnt lime with 50 parts of water, pour off the supernatant water; next, dissolve 60 parts of lump sugar in 160 parts of water, add to the solution 15 parts of the slacked lime, heat to 70-80 deg. C. and set aside, shaking frequently. Finally dissolve 50 to 60 parts of genuine Cologne glue in 250 parts of the clear solution. II. A solution of 10 parts gum arabic and 30 parts of sugar in 100 parts of soda waterglass. III. A hot solution of 50 parts of Cologne glue in 60 parts of a 20 per cent aqueous calcium chloride solution. IV. A solution of 50 parts of Cologne glue in 60 parts of acetic acid.

Utilization of Exhausted Flowers in Perfumery.—The finest and most delicate floral scents, jessamine, violet, acacia, tuberose, etc., are known to be abstracted from the flowers by cold fat over which the flowers are laid (in flowering) or by warm fat, into which they are dipped (maceration). A German firm has found that the exhausted flowers still yield perfume upon distillation with water and that relatively large quantities of the valuable odorous principle are obtained if these waters of distillation are extracted with suitable agents, such as ether, petroleum ether, benzol, chloroform, etc., subsequently concentrating the extracts.—Neueste Erfindungen und Erfahrungen.

VALUABLE BOOKS

READY THIS WEEK.

Twenty-Third Edition

EXPERIMENTAL SCIENCE.

By GEORGE M. HOPKINS.

Revised and Greatly Enlarged. 2 Octavo Volumes. 1,100 Pages. 900 Illustrations

Cloth Bound, Postpaid, **$5.00.** *Half Morocco, Postpaid,* **$7.00.**

Or Volumes Sold Separately:

Cloth, **$3.00** *per Volume. Half Morocco,* **$4.00** *per Volume.*

EXPERIMENTAL SCIENCE is so well known to many of our readers that it is hardly necessary now to give a description of this work. Mr. Hopkins decided some months ago that it would be necessary to prepare a new edition of this work in order that the many wonderful discoveries of modern times might be fully described in its pages. Since the last edition was published, wonderful developments in wireless telegraphy, for example, have been made. It was necessary, therefore, that a good deal of new matter should be added to the work in order to make it thoroughly up-to-date, and with this object in view some 200 pages have been added. On account of the increased size of the work it has been necessary to divide it into two volumes, handsomely bound in buckram. It may be interesting to note the following additions that have been made to these volumes:

Volume I contains in addition to a large number of simple, well illustrated experiments, a full description of a ¼ H. P. electric motor made expressly for illustration in this edition of "EXPERIMENTAL SCIENCE." It is an ENCLOSED SELF-REGULATING electric motor for a 110 volt circuit. It can be operated by a current from a 110 volt lamp-socket, yielding a full ¼ H. P., or it may be used as a dynamo, furnishing a current capable of operating three 16-candle power, 110 volt incandescent lamps. The construction of the machine is perfect enough to admit of enlarging or reducing its size if desired.

Volume II contains much on the general subject of electricity, besides new articles of great importance. Among these the subject of alternate current machinery is treated. Wireless Telegraphy and Telephony receive attention. Electrical Measuring Instruments, The Electric Clock, The Telegraphone, Experiments in High Voltage, The Nernst Lamp, and Measuring the Heat of the Stars are all thoroughly illustrated and described.

The unprecedented sale of this work shows conclusively that it is the book of the age for teachers, students, experimenters and all others who desire a general knowledge of Physics or Natural Philosophy.

SIXTEENTH REVISED AND ENLARGED EDITION OF 1901

THE SCIENTIFIC AMERICAN

Cyclopedia of Receipts, Notes and Queries

15,000 RECEIPTS. 734 PAGES

Price, **$5** *in Cloth;* **$6** *in Sheep;* **$6.50** *in Half Morocco, postpaid.*

This work has been revised and enlarged. **900 New Formulas.** The work is so arranged as to be of use not only to the specialist, but to the general reader. It should have a place in every home and workshop. A circular containing full Table of Contents will be sent on application.

Those who already have the Cyclopedia may obtain the **1901 APPENDIX.** Price, bound in cloth, **$1** postpaid.

The Progress of Invention in the Nineteenth Century.

By EDWARD W. BYRN, A.M.

Large Octavo. 480 Pages. 300 Illustrations. Price **$3** *by Mail, Postpaid. Half Red Morocco, Gilt Top,* **$4.**

The most important book ever published on invention and discovery. It is as readable as a novel, being written in popular style.

The book gives a most comprehensive and coherent account of the progress which distinguishes this as the "golden age of invention," resulting in industrial and commercial development which is without precedent. A chronological calendar of the leading inventions is one of the most important features of the book, enabling the reader to refer at a glance to important inventions and discoveries of any particular year. The book is printed with large type, on fine paper, and is elaborately illustrated with 300 engravings and is attractively bound.

A COMPLETE ELECTRICAL LIBRARY.

By Prof. T. O'CONOR SLOANE.

An inexpensive library of the best books on Electricity. Put up in a neat folding box. For the student, the amateur, the workshop, the electrical engineer, schools and colleges. Comprising five books as follows:

Arithmetic of Electricity, 138 pages	$1.00
Electric Toy Making, 140 pages	1.00
How to Become a Successful Electrician, 189 pages	1.00
Standard Electrical Dictionary, 682 pages	3.00
Electricity Simplified, 158 pages	1.00

Five volumes, 1,300 pages, and over 450 illustrations.

A valuable and indispensable addition to every library.

Our Great Special Offer.—We will send prepaid the above five volumes, handsomely bound in blue cloth, with silver lettering, and inclosed in a neat folding box, at the **Special Reduced Price of $5.00** for the complete set. The regular price of the five volumes is $7.00.

AN AMERICAN BOOK ON

Horseless Vehicles, Automobiles and Motor Cycles.

OPERATED BY

Steam, Hydro-Carbon, Electric and Pneumatic Motors.

By GARDNER D. HISCOX, M.E.

This work is written on a broad basis, and comprises in its scope a full illustrated description with details of the progress and manufacturing advance of one of the most important innovations of the times, contributing to the pleasure and business convenience of mankind.

The make-up and management of Automobile Vehicles of all kinds is liberally treated, and in a way that will be appreciated by those who are reaching out for a better knowledge of the new era in locomotion.

The book is up to date and very fully illustrated with various types of Horseless Carriages, Automobiles and Motor Cycles, with details of the same. Large 8vo. About 450 pages. Very fully illustrated. Price **$3.00,** postpaid.

GAS ENGINE CONSTRUCTION.

By HENRY V. A. PARSELL, Jr., Mem. A. I. Elec. Eng., and ARTHUR J. WEED, M.E.

PROFUSELY ILLUSTRATED.

This book treats of the subject more from the standpoint of practice than that of theory. The principles of operation of Gas Engines are clearly and simply described, and then the actual construction of a half-horse power engine is taken up.

First come directions for making the patterns; this is followed by all the details of the mechanical operations of finishing up and fitting the castings. It is profusely illustrated with beautiful engravings of the actual work in progress, showing the modes of chucking, turning, boring and finishing the parts in the lathe, and also plainly showing the lining up and erection of the engine.

Dimensioned working drawings give clearly the sizes and forms of the various details.

The entire engine, with the exception of the fly-wheels, is designed to be made on a simple eight-inch lathe, with slide rests.

The book closes with a chapter on American practice in Gas Engine design and gives simple rules so that anyone can figure out the dimensions of similar engines of other powers.

Every illustration in this book is new and original, having been made expressly for this work.

Large 8vo. About 300 pages. Price **$2.50,** postpaid.

MECHANICAL MOVEMENTS,

Powers, Devices, and Appliances.

By GARDNER D. HISCOX, M.E.

A Dictionary of Mechanical Movements, Powers, Devices and Appliances, embracing an illustrated description of the greatest variety of mechanical movements and devices in any language. A new work on illustrated mechanics, mechanical movements, devices and appliances, covering nearly the whole range of the practical and inventive field, for the use of Machinists, Mechanics, Inventors, Engineers, Draughtsmen, Students and all others interested in any way in the devising and operation of mechanical works of any kind.

Large 8vo. 400 pages. 1,649 illustrations. Price **$3.**

☞ *Full descriptive circulars of above books will be mailed free upon application.*

MUNN & CO. Publishers, 361 Broadway N. Y.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of The Supplement, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of The Supplement can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

Combined Rates.—One copy of Scientific American and one copy of Scientific American Supplement, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.

JUST PUBLISHED.

Practical Pointers for Patentees

Containing Valuable Information and Advice on

THE SALE OF PATENTS.

An Elucidation of the best methods Employed by the Most Successful Inventors in Handling Their Inventions.

By F. A. CRESEE, M.E. 152 Pages. Cloth. Price, **$1.00.**

This is the most practical, up-to-date book published in the interest of Patentees, setting forth the best methods employed by the most successful Inventors in handling their patents. It is written expressly for Patentees by a practical Inventor, and is based upon the experience of some of the most successful Inventors of the day.

It gives exactly that information and advice about handling patents that should be possessed by every Inventor who would achieve success by his ingenuity, and will save the cost of many expensive experiments as well as much valuable time in realizing from your inventions. It contains no advertisements of any description, and is published in the interests of the Patentee alone, and its only object is to give him such practical information and advice as will enable him to intelligently handle his patent successfully, economically and profitably.

It gives a vast amount of valuable information along this line that can only be acquired by long, expensive experience in realizing from the monopoly afforded by a patent. *Send for Descriptive Circular.*

MUNN & CO., Publishers, 361 Broadway, New York

The New Supplement Catalogue

Just Published

A large edition of the Supplement Catalogue in which is contained a complete list of valuable papers down to the year 1902, is now ready for distribution, free of charge. The new Catalogue is exactly like the old in form, and is brought strictly up to date. All the papers listed are in print and can be sent at once at the cost of ten cents each, to any part of the world. The Catalogue contains 60 three-column pages and comprises 15,000 papers. The Catalogue has been very carefully prepared and contains papers in which information is given that cannot be procured in many text-books published. Write to

MUNN & CO., Publishers, - 361 Broadway, New York,

for the new Catalogue.

PATENTS!

MUNN & CO., in connection with the publication of the Scientific American, continue to examine improvements, and to act as Solicitors of Patents for Inventors.

In this line of business they have had over *fifty years' experience*, and now have *unequaled facilities* for the preparation of Patent Drawings, Specifications, and the prosecution of Applications for Patents in the United States, Canada, and Foreign Countries. Messrs. Munn & Co. also attend to the preparation of Caveats, Copyrights for Books, Trade Marks, Reissues, Assignments, and Reports on Infringements of Patents. All business intrusted to them is done with special care and promptness, on very reasonable terms.

A pamphlet sent free of charge on application containing full information about Patents and how to procure them; directions concerning Trade Marks, Copyrights, Designs, Patents, Appeals, Reissues, Infringements, Assignments, Rejected Cases, Hints on the Sale of Patents, etc.

We also send, *free of charge*, a Synopsis of Foreign Patent Laws showing the cost and method of securing patents in all the principal countries of the world.

MUNN & CO., Solicitors of Patents,
361 Broadway, New York.

BRANCH OFFICES.—No. 625 F Street, Washington, D. C.